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MBA PROFESSIONAL REPORT

Accounting for Uncertainty in a Business Case Analysis for Implementing Advanced Technology Ordnance Surveillance in a Munitions Management Environment

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By: **Andrzej Kuklewski**
March 2006

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The approach taken to support the ROI analysis was to build a model consistent with the need for a Business Case Analysis (BCA) for an ATOS Advanced Concept Technology Demonstration (ACTD), which allows generating the return on investment distribution, while also assuming a range of uncertain savings assumptions. Additionally, the model that was built required testing with notional data in order to evaluate its functionality.

The results of this project are that:

– there is a ROI model built, tested and proven to work;
– the model is ready to be filled with real data and to work to support the ATOS pilot project.

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ACCOUNTING FOR UNCERTAINTY IN A BUSINESS CASE ANALYSIS FOR IMPLEMENTING ADVANCED TECHNOLOGY ORDNANCE SURVEILLANCE IN A MUNITIONS MANAGEMENT ENVIRONMENT

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I. INTRODUCTION

A. BACKGROUND

1. Automatic Identification Systems (AISs)

a. Definition

Automatic Identification Systems are systems that automatically recognize objects, gather and enter information about them into computer systems without human involvement.[1] They have been intensively developed to provide valuable data concerning people, animals, and supply chain patterns.[2]

b. Utility

The Automated Identification Systems are especially appreciated by many business and the public sector for their utility. AISs are broadly used in service industries, supply logistics and at retail, operations management and production. They allow for the collection and processing of large amount of data with none or minimum human involvement. The advantages of AISs are low operating costs and robust capabilities. Thanks to automated data gathering, it is possible to eliminate such time consuming activities as reading, counting and segregating items, and writing reports or typing in order to input information.

c. Example Implementations[3]

The most known AISs today are bar codes, RFID, magnetic stripes, optical character recognition (OCR), smart cards and biometrics, including fingerprint or voice recognition. Each of these methods uses different techniques for object identification, and each method has its own advantages and limitations.

(1) Barcode Systems. Barcodes have been in use since the 1970s. Finkenzeller describes the barcode as:

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[1] Wikipedia.com, http://en.wikipedia.org/wiki/Automatic_identification (accessed February 6, 2006).

[2] Klaus Finkenzeller, RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identifications (Chichester, England: John Wiley and Sons Ltd., 2004), 1.

[3] Ibid, 2.

> a binary code comprising a field of bars and gaps arranged in a parallel configuration. They are arranged according to a predetermined pattern and represent data elements that refer to an associated symbol. The sequence, made up of wide and narrow bars and gaps, can be interpreted numerically and alphabetically. It is red by optical laser scanning, i.e. by the different reflection of a laser beam from the black bars and white gaps.[4]

He also says that there are about ten different kinds of barcodes; among them: the European Article Number (EAN) code, the Universal Product Code (UPC), the Code Codabar, the Code 2/5 and the Code 39. The differences include the different layouts of the barcodes and the information they can carry. According to Finkenzeller, barcodes are very cheap, but have the serious disadvantages due to limited data storage capacity and lack of upgradeability.

(2) Optical Character Recognition. Optical Character Recognition is a system of special fonts which can be read by people as well as automatic readers. OCR was launched in the 1960s and accepted in production, service industry, administration and banking (registration of checks). The data written in this system has the advantage of being high density and easily readable by people. Despite its advantages, OCR is not commonly used because of its high cost and the complicated readers.

(3) Biometric Identification Systems. Biometric Identification Systems are used to identify people. They recognize individual physical characteristics of the identified person by comparing said person to the data stored in databases. Biometric Identification Systems are commonly base on voice pattern, fingerprints and less often on retina identification.

(4) Smart Cards. A smart card is an electronic device capable of storing data and sometimes computing data (microprocessor card), built into a plastic card. Table 1 summaries the four AIS approaches listed above.

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4 Klaus Finkenzeller, RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identifications (Chichester, England: John Wiley and Sons Ltd., 2004), 3.

	Description	Launched	Advantages	Disadvantages	Where Used
Barcode Systems	a binary code composed of bars and gaps arranged parallel according to a predetermined pattern and representing data	1970s	extremely cheap	limited capacity, not upgradeable data	sales
Optical Character Recognition (OCR)	system of special fonts which can be read by people as well as readers	1960s	high density of information; possibility of reading data in the normal way by people	complicated expensive readers	production; service and administration; banking (registration of checks)
Biometric Identification System	recognizes individual physical characteristics of identified person by comparing said person to the data stored in databases		No ID card or password needed. Low False Acceptance Rate	Each person's characteristic must be "scanned" and stored in a database; high cost; false rejection	Entry control systems, personnel identification
Smart cards	A smart card is an electronic device capable of storing data and sometimes computing data (microprocessor card), built into a plastic card.	1984	save from distant read and manipulation; cheap and fast to operate;	galvanic contacts vulnerable to wear, corrosion and dirt; readers are expensive to maintain	banking; access control; telephone cards;

Table 1. Automatic Identification Systems Usage

(5) Radio Frequency Identification (RFID). One of the means of implementing AISs. RFID relies on storing and remotely retrieving data using devices called RFID tags or transponders.[5] The automatic identification systems may be, also, based on barcodes, optical character recognition, biometrics and smart cards.[6] Transponders, next to readers and data collection applications, are the three typical RFID system components.[7] In general, the reader first sends the electromagnetic wave at a certain frequency (query) to the RFID tag. That query activates the tag, and the tag responds by sending data to the reader. The reader exchanges the data with the data collection application.

5 http://en.wikipedia.org/wiki/RFID (accessed December 28, 2005).

6 Klaus Finkenzeller, *RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identifications* (Chichester, England: John Wiley and Sons Ltd., 2004).

7 Steven Shepard, *RFID: Radio Frequency Identification* (New York: McGraw-Hill, 2005), 55.

d. RFID Tags

The transponder (RFID tag) is a device that is attached or incorporated into an item, animal or person. The tag contains an antenna and microprocessor. Tags store data associated with the object. In writable transponders, the data can be updated by the reader. Tags may have various shapes, sizes and additional capacities, such as pressure measuring, depending on its required characteristics.

There are active or passive RFID tags. The active tags are equipped with battery power. This power is used to transmit the tag's response for a query. The active RFID tags can transmit at a distance as great as 100 feet or more.[8] The passive tags, on the other hand, rely only on the energy received through their antennas. This energy, containing a query, must be much higher than in the case of active tags. This may cause problems in certain environments.

e. Hazard of Electromagnetic Radiation to Ordnance (HERO)

HERO is possible whenever the radiofrequency transmitters interact with ordnance. The Defense Acquisition Guidebook defines HERO as "the hazards that result from adverse interactions between radio frequency (RF) emitters and electrically initiated devices or initiating systems contained within ordnance systems (e.g., fuses)."[9]

Current requirements for Automated Identification Technology (AIT) are stated in NAVSEA INST 8020.7D:

> Prior to service use, all electronic equipment that intentionally or unintentionally generates radio frequency energy for use to identify or track ordnance or to be used within magazine or ordnance assembly/disassembly areas shall be evaluated by the Commanding Officer, Naval Ordnance Safety and Security Activity Weapons and Explosive Safety Office (N71) and certified for use. The certification process involves comparing the radiated emission characteristics of the device with respect to potential ordnance susceptibilities and determining

[8] Patrick J. Sweeney II, *RFID for Dummies* (Indianapolis, Indiana: Wiley Publishing, Inc., 2005), 43.

[9] Defense Acquisition Guidebook, http://akss.dau.mil/dag/Guidebook/IG_c9.9.3.1.asp (accessed February 3, 2006).

safe separation distances. NAVSEA OP 3565 will contain a list of approved equipment with their associated safe separation distances.[10]

The RFID tags, in order to be activated, need an electromagnetic query sent by readers. These queries can potentially cause an accidental triggering action on electro-explosive devices. The passive tags require much more power received from the querying reader than do the active tags. The level of energy sent to passive RFID tags may cause Hazard of Electromagnetic Radiation to Ordnance. Therefore, only active RFID tags are able to obtain HERO certification.

f. Readers

A reader is a stationed or hand held device for exchanging data between RFID tags and the data collection application. Depending on the system used, readers may only read the information carried by the RFID tags without changing it, or read and write the data to the tag's memory.

g. The Data Collection Application

According to Steven Sheppard, the data collection application "receives data from the reader, enters the data into the database, and provides access to the data in a number of forms that are useful to the sponsoring organization."[11]

2. Radio Frequency Usage Matrix

RFID technology is becoming more and more popular in many commercial and government usages. Table 2 describes certain areas of RFID usage.[12]

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[10] D. Mark Johnson, Electromagnetic Environmental Effects (E3): Ongoing Efforts on Automated Identification Technology E3 Issues, PowerPoint presentation, http://www.dodait.com/conf/AF0803/JOHNSON-HAZARDS.ppt#396,21,Slide 21 (accessed February 7, 2006).

[11] Steven Shepard, *RFID: Radio Frequency Identification* (New York: McGraw-Hill, 2005), 55.

[12] Klaus Finkenzeller, *RFID Handbook: Fundamentals and Applications in Contactless Smart Cards and Identifications* (Chichester, England: John Wiley and Sons Ltd., 2004), 365.

Area	Application	Accomplishments
Transport	*Eurobalise S21*	Managing the safety of trains crossing the European countries
	International container transport	More accurate container management
Ticketing	– cards or wristwatches – frequent flier loyalty cards	– low ticket issuing price – valuable statistical data
Access control	Online systems	Large amount of people access through multiple gates / doors
Animal identification	Tags attached or injected to livestock	– automatic feeding and productivity control – origin tracking – epidemics control – quality control
Container identification	Gas bottles and chemical containers control	– enhancement of safety precautions, containers and inventory management
Waste disposal	Recording the actual amount of waste collected from each tagged container	– accurate billing which leads to better waste management
Sporting events	Tags attached to shoes and reader antennas at start and finish lines.	– accurate measurement of runners scores during mass sporting events
Industrial automation	Tool identification	– faster tool recognition; – enhanced personnel safety; – lower production cost – enhanced tool management, maintenance records, etc.
	Industrial production – tags associated with each manufactured item and readers at production, or assembly stations	– faster, more efficient production at lower cost – just-in time or lean production enabled due to fast tool recognition and changing
Medical applications	Interocular pressure sensor	– reading Interocular pressure

Table 2. RFID Technology Usage

3. Advanced Technology Ordnance Surveillance

a. What is ATOS?

ATOS is a system of Radio Frequency Identification tags and readers able to perform remotely ordnance inventory surveillance and monitoring of storage environmental conditions. A description of the major components of ATOS follows.

(1) RFID Tags. The ATOS type RFID tags are active tags, manufactured by Phase IV Engineering, Inc. headquartered in Boulder, Colorado. The tags are equipped with sensors (temperature, relative humidity, and gravity-shock), receiver, transmitter and memory. As the manufacturing company claims: "The ATOS tag is capable of storing up to 4 MB of data with programmable data fields; transmitting at data rates of up to 100Kbs; providing accurate temperature and humidity data; storing temperature and humidity limits that trigger alarms; operating in severe environmental conditions (including submersed in water for up to 30 minutes); and operating safely when attached directly to ordnance."[13] The gravity-shock sensors need further development and testing.[14] Further description and comparison of ATOS tags' capabilities versus other RFID tags appears in Chapter III.

(2) Handheld Reader (HHR). A handheld reader is capable of reading and writing information stored in tag's memory as well as reading linear and two dimensional bar codes. The reader uses commercial off the shelf (COTS) software.

(3) Reader Control Unit (RCU). The reader control unit reads asset and environmental data from RFID tags using an interrogation function. The interrogation consists of two independent types of reads: short and long.

> The short read determines the number of RF tags detected, RF tag identification (ID), Department of Defense Identification Code (DODIC), National Stock Number (NSN), consignee, any environmental sensor flags, and a low battery flag. The time duration for a short read depends upon the number of RFEs connected in series with the RCU, the number of RF tags detected inside the storage facility, and the type of material

[13] Phase IV Systems, Inc. website, http://www.phaseivengr.com/SuccessStories.htm (accessed February 2, 2006).

[14] Advanced Technology Ordnance Surveillance Advanced Concept Technology Demonstration: Military Utility Assessment Final Report, US Air Force Operational Test and Evaluation Center (AFOTEC) Detachment 1, December 2004.

> (wooden crates and aluminum pallets) on which the RF tags were attached. The long read downloads the remaining asset information and environmental data. The duration of a long read can take hours to days depending on the number of RF tags being interrogated. The RCU serves as a long-term data storage unit for receiving and storing interrogated RF tag data. The RCU stores these data until the PP commands it to transfer the data via a wireless local area network (WLAN), local area network (LAN), serial cable connection with the HHR. The RCU has no direct user interface (i.e., no keyboard or display).[15]

b. Successful and Meaningful Implementation

Advanced Technology Ordnance Surveillance is a highly technology intensive concept. As Mark Maier notices, to implement such a system successfully, one needs to understand that there is a great risk in

> not recognizing that before they are completed, technology-driven architectures will require much more than just replacing components of an older technology on each time. Painful experience shows that without widespread changes in system and its management, technology-driven initiatives seldom meet expectations and too often cost more for less value. As examples, direct replacements of factory workers with machines, of vacuum tubes with transistors, of large inventories with Just-In-Time deliveries, and of experienced analysts with computerized management information systems, all collapsed when attempted by themselves in systems that where otherwise unchanged. They succeeded only when incorporated in concert with other matched and planned changes. It is not much of an exaggeration to say that the letter successes were well architected, the former failures were not.[16]

Before making a decision concerning the radiofrequency implementation, there should be a return on investment analysis made. Mark Mentikov, the Resource Branch Supervisor of the Navy Region Southwest Ordnance Program, in his paper *Anchoring Sea Enterprise: Planning for the Successful Implementation of Radio Frequency Identification (RFID)* (see Appendix C) wrote:

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[15] Advanced Technology Ordnance Surveillance Advanced Concept Technology Demonstration: Military Utility Assessment Final Report, US Air Force Operational Test and Evaluation Center (AFOTEC) Detachment 1, December 2004, 14.

[16] Mark W. Maier, ed., Eberhardt Rechtin, ed., *The Art of Systems Engineering* (Boca Raton, Fl: CRC Press LLC, 2002), 41.

> the benefits should include both direct benefits in labor savings as well as indirect savings and benefits to total asset visibility in being able to accurately track shipments throughout the movement and delivery process, down to management of material within the warehouse. The benefits and features provided from RFID technology are impressive; however, one must remember that they are potential features and benefits, not guaranteed ones. It is the understanding of what can truly be delivered and utilized in the individual implementation plan that determines the project's success or failure.[17]

Further, he explains:

> Only after the process has been re-engineered and efficiencies been made, should a pursuit of automation occur. Integration is a requisite step occurring subsequent to process and return on investment analysis and is not a prerequisite. If an inefficient process is automated inefficiencies are performed faster providing a false positive result.[18]

Implementing technology change in an inefficient organization may easily spoil the effect. The key word for this consideration is *transformation*. The Naval Weapon Station in Seal Beach, CA is a munitions managing organization subject to the FAIR act and underwent an A-76 competition, which led to a significant business process transformation. According to Mr. Mark Mentikov, the Naval Weapon Station Seal Beach achieved over 30% improvement in operations efficiency due to the A-76 implementation.

4. A-76 Transformation

a. The Federal Activities Inventory Reform Act of 1998 (FAIR Act)[19]

The Federal Activities Inventory Reform Act of 1998 was signed into law on October 12, 1998. The FAIR Act directs all government agencies to develop complete lists of their "commercial activities" performed by Federal employees, with their associated Full-Time-Equivalents (FTE). Each fiscal year the lists must be submitted to

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[17] Mark Mentikov, *Anchoring Sea Enterprise: Planning for the Successful Implementation of Radio Frequency Identification (RFID)*, Pacific Fleet Ordnance AIT Program, 6.

[18] Ibid, 9.

[19] *Implementation of the Federal Activities Inventory Reform Act o f1998, (Public Law 105-270) ("the FAIR Act")*, Office of Management and Budget, http://www.whitehouse.gov/omb/fedreg/fair-act.html (accessed February 6, 2006).

the Office of Management and Budget (OMB) for revision and consultation with the agencies. After the consultation, the lists are introduced to Congress and the public, and are subject to challenges and appeals by "interested parties."[20]

Agencies must compare the costs of performing commercial activities by governmental source and a private-sector source.

Under the FAIR Act, when an agency considers contracting with a private-sector source for the performance of an activity on the inventory, it must use a competitive process to select the source and must ensure that all costs are considered (including certain specified costs) and that the costs considered are realistic and fair.[21]

The Federal policy concerning implementation of the FAIR Act is stated in Circular A-76. The Supplement to A-76 sets forth the procedures for determining whether commercial activities should be performed under contract with commercial sources or in-house using Government facilities and personnel.[22]

b. Commercial Activities (CA)

A commercial activity is the process resulting in a product or service that is or could be obtained from a private sector source. Agency missions may be accomplished through commercial Real Property Management and resources, Government Real Property Management and resources or mixes thereof, depending upon the product, service, type of mission and the equipment required.[23]

c. A-76/Competitive Sourcing

Competitive sourcing (A-76), a major initiative of the President's Management Agenda, is a process for determining the most effective and efficient way to do certain types of work (functions) done by Government employees. A cost comparison competition determines whether the function will continue to be done by Federal

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[20] *Implementation of the Federal Activities Inventory Reform Act o f1998, (Public Law 105-270) ("the FAIR Act"),* Office of Management and Budget, http://www.whitehouse.gov/omb/fedreg/fair-act.html (accessed February 6, 2006).

[21] Ibid.

[22] http://www.whitehouse.gov/omb/circulars/a076/a076.html (accessed February 7, 2006).

[23] National Institutes of Health Webpage, http://a-76.nih.gov/PrevDefofTerms.htm (accessed February 6, 2006).

employees or whether it can be accomplished with a contractor. Regardless of who wins the competition though, the duties of employees currently doing that function will be changed and some may no longer have those duties. In response to employee concerns, the Secretary of Health and Human Services has stated that every employee will have a job. NIH has tools in place to minimize the possible impacts on affected employees. This web page provides information about those tools.[24]

d. Most Efficient Organization (MEO)

The MEO refers to the Government's in-house organization to perform a commercial activity. It may include a mix of Federal employees and contract support. It is the basis for all Government costs entered in the Cost Comparison Form. The Most Efficient Organization (MEO) is the product of the Management Plan and is based upon the Performance Work Statement (PWS).[25]

5. Advanced Concept Technology Demonstration Program

The Advanced Concept Technology Demonstration process was initiated to permit the early and inexpensive evaluation of mature advanced technology to meet the needs of the warfighter. The evaluation is accomplished by the warfighter to determine military utility before a commitment is made to proceed with formal acquisition. ACTDs also allow the warfighter to develop and refine operational concepts to take full advantage of the new capability. Upon conclusion, a successful ACTD may leave behind a residual operational capability. The capability can be replicated, if only a few are required, or can be transitioned into the appropriate phase of formal acquisition.[26]

The US European Command (USEUCOM) sponsored the Department of the Navy ATOS ACTD. The Detachment 1 (Det 1) of the Air Force Operational Test and Evaluation Center (AFOTEC) conducted the military utility assessment (MUA) of ATOS. The ATOS ACTD final report states that: "the system demonstrated potential military utility by providing the warfighter near-real time environmental surveillance data

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[24] Office of Strategic Management Planning Webpage, National Institutes of Health, U.S. Department of Health and Human Services, http://osmp.od.nih.gov/a76.asp (accessed February 6, 2006).

[25] Ibid.

[26] Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics Webpage, http://www.acq.osd.mil/actd/qa.htm#What (accessed March 11, 2006).

and supporting five out of the six munitions management tasks during the demonstrations."[27] The full report of this MUA can be found in Appendix B of Kratzer's thesis entitled *A Methodological Approach for Conducting a Business Case Analysis for the Advanced Technology Ordnance Surveillance (ATOS) Advanced Concept Technology Demonstration (ACTD).*[28]

6. Turbo CADS Exercise

In 2005, an exercise called Turbo CADS was held. The information concerning the Turbo CADS 2005 exercise, placed in this paper, is based on:

- Mr. Mark Mentikov's paper entitled Anchoring Sea Enterprise: Planning for the Successful Implementation of Radio Frequency Identification (RFID)
- Interview with Mr. Mentikov on January 27, 2006 at Naval Weapon Station Seal Beach, CA
- Phase IV Engineering webpage[29]

a. Background

ATOS has been under development since 1994. The technology was evaluated and compared to the current radiofrequency technology capabilities during the Turbo CADS exercise in 2005. Turbo CADS is a containerized ammunition distribution system (CADS) exercise designed to test joint capabilities to transport munitions via military 20-foot shipping containers.[30]

b. Objective

The objective of the Turbo CADS exercise was to compare current RFID technologies, *SAVI, ATOS* and *Land Mark – Gen2,* including their maturity and

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[27] Advanced Technology Ordnance Surveillance Advanced Concept Technology Demonstration: Military Utility Assessment Final Report, US Air Force Operational Test and Evaluation Center (AFOTEC) Detachment 1, December 2004, 1.

[28] Gadala E. Kratzer, *A Methodological Approach for Conducting a Business Case Analysis for the Advanced Technology Ordnance Surveillance (ATOS) Advanced Concept Technology Demonstration (ACTD),* (Monterey: Naval Postgraduate School, 2005), http://library.nps.navy.mil/uhtbin/cgisirsi/kgu4naLj0f/SIRSI/170430048/523/9572 (accessed March 15, 2006).

[29] Phase IV Engineering, Inc. Webpage, http://www.phaseivengr.com/ SuccessStories.htm (accessed February 5, 2006).

[30] GlobalSecurity.org website, http://www.globalsecurity.org/military/ops/turbo-cads.htm (accessed February 5, 2006).

capabilities. Most important was a determination if any of the current systems could provide In-Transit Visibility (ITV) as well as communication with the active tags at the pallet level. These capabilities are required for Total Asset Visibility (TAV).

c. Methodology[31]

The scenario of the Turbo CADS exercise was to transport tagged shipping containers containing tagged ammunition. The containers were sent from the Naval Surface Warfare Center in Crane, Indiana to COMNAVMAR Guam. Five of these containers were equipped with satellite communication devices. There was satellite communication between the containers' tags, the Navy's Ordnance Information System and the DoD in Transit Visibility (ITV) Server six times per day (or every two hours).

d. Results

The Turbo CADS 2005 exercise results show that the three examined technologies have different utility levels. According to Mr. Mentikov, the Land Mark Gen2 technology outweighs, in terms of its capabilities and accessibility, the other two.

(1) SAVI Tags. SAVI tags, which have been in use by the US Army, have a number of limitations. In general:

- The tags are outdated, generation one (Gen1) technology, which is not user friendly, and does not provide in transit visibility
- The tags do not have the capability to communicate among themselves (networking capability), and
- Lack the capability to automatically update the data they carry;
- This technology is not compatible with other, not *SAVI,* solutions.
- The technology requires heavy investment in fixed equipment, such as interrogators hardwired to the server, which is expensive to maintain due to proprietary rights.

(2) ATOS Tags. ATOS tags also lack the networking capability and ability to upgrade information written in the tag's memory automatically. The technology limitations include an inability to communicate with the master tags, attached to pallets or containers, and to communicate with pallet (or container) level tags. The information exchange and update must be done manually using handheld readers. It

31 Phase IV Engineering, Inc. Webpage, http://www.phaseivengr.com/ SuccessStories.htm (accessed February 5, 2006).

seems that, one conclusion from the exercise is that, using ATOS tags is more justified in a static, rather than in a dynamic, environment. ATOS can prove its value when used with expensive, high labor intensive and dangerous static ordnance (hand grenades, etc.). That ordnance, in the munitions inventory enterprise, is called *Category 1* and *Category 2*. These munitions categories need to be inspected every six, or 12 months, respectively.

(3) Land Mark Tags. Land Mark tags (Gen2) produced by the Georgia Institute of Technology "passed the exam" during the Turbo CADS 2005 exercise.[32] This technology allows real time in transit visibility at a lower cost than the Gen1 technology. The actual advantage of this technology is that the tags "communicate" among themselves and require fewer interrogators and readers.

e. Generation II tags

The second generation RFID tags are networkable active tags. The RFID II technology is used in tagging containers with V-22 Osprey spare engines. It is described in an article entitled *Navy Revs Up RFID Sensors*[33] published on the RFID Journal webpage. The article describes this technology. A paragraph from this article appears below.

> Working with researchers at the Georgia Institute of Technology in Atlanta, the Navy has come up with an RFID system that doesn't use RFID readers to scan each tag, but instead uses battery-powered tags that can pass information from one to another until the data reaches the last transponder, which communicates with a single reader.[34]

The second generation has some significant advanntages over the first generation RFID:.

- Networkability; the tags are able to communicate among themselves, create a mash network, exchange and update the information they carry. It enables real time visibility;
- Each tag, within a mash network, can be remotely located;

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[32] Mark Mentikov, personal interview, January 28, 2006.

[33] Mark Roberti, "Navy Revs Up RFID Sensors," RFID Journal, http://www.rfidjournal.com/article/articleview/990/1/1/ (accessed March 16, 2006).

[34] Ibid.

- Much less upfront investment in fixed equipment required (less interrogators, extenders, readers needed because the tags create their own network);
- The tags do not broadcast information unless they are interrogated by a base station, which sends out a security code, which saves the life of the battery. It also prevents the tag from potentially alerting an enemy to the position of a ship at sea or allowing someone to gain access to inventory information without authority.[35]

[35] Mark Roberti, "Navy Revs Up RFID Sensors," RFID Journal, http://www.rfidjournal.com/article/articleview/990/1/1/ (accessed March 16, 2006).

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II. OTHER STUDIES

A. LT KRATZER'S THESIS

Lieutenant Kratzer completed a study entitled *A Methodological Approach for Conducting a Business Case Analysis for the Advanced Technology Ordnance Surveillance (ATOS) Advanced Concept Technology Demonstration (ACTD).*[36] A summary of this work follows:

- the technology for ATOS is a Commercial Off-the-Shelf (COTS) product. However, it needs some enhancement in order to meet security requirements;
- it is highly probable that ATOS, with its capabilities, may greatly improve Ordnance Management, especially the corrosion maintenance and Quality Evaluation. Moreover, based on notional data concerning ATOS implementation in an exemplar site, a Business Case Analysis indicated an investment payback period of less than one year.
- the data to support the ATOS ROI are not fully available; therefore, there is a need to conduct a pilot project which will ensure certainty over the advantages of ATOS.

B. OTHER STUDIES

1. Professional Reports

This section of the thesis presents one technical and four MBA reports published at the Naval Postgraduate School in 2003 – 2005. All these works are focused on a RFID usage in a United States military environment. Three describe a radiofrequency employment as an in-transit visibility tool and the other two an in place asset management.

First and most significant is a collective work of Kenneth H. Doerr, William R. Gates and John E. Mutty. It is a technical report, prepared for the Naval Surface Warfare Center, entitled *A Hybrid Approach to the Validation of RFID/MEMS Technology Applied to Ordnance Inventory*. The authors made a cost benefit analysis of

[36] Gadala E. Kratzer, *A Methodological Approach for Conducting a Business Case Analysis for the Advanced Technology Ordnance Surveillance (ATOS) Advanced Concept Technology Demonstration (ACTD)*, (Monterey: Naval Postgraduate School, 2005), http://library.nps.navy.mil/uhtbin/cgisirsi/kgu4naLj0f/SIRSI/170430048/523/9572 (accessed March 15, 2006).

implementing FRID technology with munitions management. The benefit analysis was based on a multiple qualitative criteria factorial model combined with a Monte Carlo analysis of those criteria. The report shows the great importance of the qualitative financial factors to the overall benefits of the project and proves the need for further analysis of those factors.

Hozven and Clark[37] in their paper present the actual and potential value of the radiofrequency technology for the military, and in particular for the Air Mobility Command (AMC), a part of the United States Transportation Command. They not only describe AMC's role in the U.S. military logistic supply system, but also how the radiofrequency technology can influence it. They picture the RFID and Automated Information System's infrastructure within the Global Air Transportation Execution System. They conclude that there is a minor value in current radiofrequency technology for AMC. However, they underline the importance of current pilot RFID projects for achieving future benefits.

Corrigan and Kielar discuss the same value that RFID may bring to the military supply chain.[38] Based on the results of a survey distributed to the Naval Supply Corps Officers, they even determined a price, in terms of money, which a warfigher is willing to pay for accurate information concerning in-transit supplies. The study also lists intangible benefits, such as "improved decision-making" possibly thanks to better inventory visibility. Corrigan and Kielar stress the fact that the radiofrequency alone, without a reliable communication system, is not sufficient.

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37 Marcelo Hozven and George Clark, *DoD Supply Chain Implications of Radio Frequency Identification (RFID) Use within Air Mobility Command (AMC)*, (Monterey: Naval Postgraduate School, 2003), http://library.nps.navy.mil/uhtbin/hyperion/ 03Dec%5FHozven%5FMBA.pdf, (accessed September 16, 2005).

38 Christopher Corrigan and Jayson Kielar, *The Value of Logistics Information to the Warfighter*, (Monterey: Naval Postgraduate School, 2004), http://library.nps.navy.mil/uhtbin/cgisirsi/d09cXooUTW/SIRSI/163690015/523/6460, (accessed September 16, 2005).

The other MBA report describes in place asset visibility improvement. Sánchez, Chávez and Nixon[39] analyze the use of the radiofrequency technology to track medical equipment better at the Naval Medical Center in San Diego. They conclude the benefits of such use in savings in the cost of lost tools replacement and time spent to locate them.

Similarly, Miertschin and Forrest[40] examine the result of a pilot program conducted at the Tobyhanna Army Maintenance Depot. The RFID technology was used for tracking components of maintained disassembled systems. This report highlights the benefits of such a RFID usage, such as labor hour savings or better management. These last two references stress that further pilot programs should be run.

2. Articles

Cathy Booth-Thomas in the article "The see-it-all chip"[41] provides an extensive amount of actual and potential RFID usage. The article gives examples of a wide usage of radio frequency technology in many areas from retail, financial services, and household appliances to the military. Among a variety of examples of actual FRID tags usage she describes, the earliest, from 1993, was implemented by the Ford Motor Company in anti-theft systems. Others are:

- in 1997, Procter & Gamble tracked its exceptional inventory – the Oil of Olay's ColorMoist Hazelnut No. 650 in order to reorder it on time and prevent stealing;
- ExpressPay of American Express and ExxonMobil's Speedpass;
- The biggest European investment into gourmet take-home foods tracking systems used by 300 suppliers to 200 Marks & Spencer stores;
- Ariston's appliances such as washing machines and refrigerators with their huge future potential.

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39 Joaquín Sánchez and Sergio Chávez and Richard Nixon, *Medical Equipment Management through The Use of Radio Frequency Identification (RFID),* (Monterey: Naval Postgraduate School, 2004) http://library.nps.navy.mil/uhtbin/hyperion/04Dec% 5FSanchez%5FMBA.pdf, (accessed September 16, 2005).

40 Keith W. Miertschin and Brian D. Forrest, *Analysis of Tobyanna Army Depot's Radio Frequency Identification (RFID) Pilot Program: RFID as an Asset Management Tool*, (Monterey: Naval Postgraduate School, 2005), http://library.nps.navy.mil/ uhtbin/hyperion/05Jun%5FMiertschin%5FMBA.pdf, (accessed September 16, 2005).

41 Cathy Booth-Thomas, "The See-It-All Chip," Time, September 22, 2003, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=411078261&sid=1&Fmt=3&clientId=11969&RQT=309&VName=PQD (accessed September 17, 2005).

Booth-Thomas shows the United States military as possibly the biggest user of the RFID technology for tracking "300,000 containers in 40 countries every day" or, more surprisingly, tracking personnel, such as injured soldiers, civilians and Prisoners of War.

The author points out that the radiofrequency technology is not new. It was used over 60 years ago, during World War II, by the Britons for the Identification Friend or Foe (IFF) of incoming aircrafts.

Finally, Booth-Thomas in her article, not only specifies new trends in the usage of RFID tags, but mentions also a social anxiety against tagging every commercial item. The same human barriers are pointed out by Shane Harris in "It's a Tag, Tag, Tag, Tag World."[42] Harris describes Paharia's "three-pronged model showing the trade-offs between privacy, choice, and the benefits" for RFID users. Rajat Paharia is a former senior designer at the Palo Alto design company Ideo.

Harris also considers security issues for such a radiofrequency usage like issuing passports fitted with RFID tags. The author presents privacy advocates' fear that "identity thieves, terrorists, digital hackers, or law enforcement officers" may secretly scan these tags.

In the article "Radio Frequency Ready to Deliver", Henry Kenyon[43] discuses the value which the radiofrequency technology brings to commercial and military supply chains. The author quotes Mr. Richard Dean, program director of International Data Corporation, and Mr. Patrick Sweeney, president and chief executive officer of ODIN Technologies. They explain how the RFID technology improves the supply chain in the context of just-in-time manufacturing and delivery, or supply strategies. The article shows examples of the savings of commercial companies and the United States military. It also describes how an "inside the box" visibility" works.

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42 Shane Harris, "It's a Tag, Tag, Tag, Tag World," Government Executive, March 15, 2005, http://libproxy.nps.navy .mil/login?url=http://proquest.umi.com/pqdweb?did= 811464681&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

43 Henry Kenyon, "Radio Frequency Identification Ready to Deliver," Signal, January 2005, http://libproxy.nps.navy .mil/login?url=http://proquest.umi.com/pqdweb? did=783851551&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

Kenyon shows up-to date RFID usage and predicts a future RFID usage growth in quantity and variety. He features examples in a world of commerce and governmental agencies, such as United States Department of Homeland Security.

In this article, Kenyon presents Sweeney's advice regarding common technology pitfalls when using the RFID technology. He explains what those "unforeseen problems" are and from what reasons.

Among references providing information about the technical features of radiofrequency tags, the most valuable is Karen Schwartz's article "Tag Team."[44] The author presents comprehensive knowledge of technical characteristics and the differences of active and passive RFID tags, as well as bar codes. She describes, by citing the DoD officials, usage of the radiofrequency technology by the U.S. military.

Schwartz emphasizes the fact, that in order to achieve savings promised by the RFID implementation, the uniform radiofrequency standard must be agreed to, both for tags and readers, within the military and commercial world. DoD officials' extensive discussion on RFID standardization is presented by Sandra Erwin in "Tagging War Shipments: Far More Complicated Task Than Expected."[45]

The Department of Defense policy regarding implementing radio frequency identification was issued July 30, 2004, by the Acting Under Secretary of Defense for Acquisition, Technology, and Logistics.[46] The article titled "RFID Vision in the DOD Supply Chain" by Alan Estevez studies the practical and technical nature of this implementation. Alan Estevez is the Assistant Deputy Under Secretary of Defense for Supply Chain Integration within the Office of Deputy Under Secretary of Defense for

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44 Karen Schwartz, "Tag Team," Government Executive, May 1, 2004, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=636011601&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

45 Sandra Erwin, "Tagging War Shipments: Far More Complicated Task than Expected," National Defense, July 2004, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=668132241&Fmt=3&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

46 Alan Estevez, "RFID Vision in the DOD Supply Chain," Army Logistician, May/June 2005, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=839110291&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

Logistics and Materiel Readiness. He stresses the value of information to the military logistics and a role that RFID plays or may play to acquire this information. The author describes RFID as a visibility tool which can help increase operational availability and readiness.

Estevez focuses on differences in usage and function of active and passive radiofrequency tags. He pictures a history of their usage in logistics and current "marriage of active and passive RFID" and its advantages. He describes a complement of both types of tags in accordance with DoD policy. He also portrays other policy's requirements and directions for RFID usage, such as ful implementation by 2008. He features a unique identification (UID) system and automatic identification technologies (AITs) and their combination with radiofrequency identification. This article also compares two-dimensional barcode and radiofrequency tags.

Harold Kennedy, in the article entitled, "Contractors Urged to Comply with Smart-Tag Policy,"[47] describes the contractors' response to the DoD policy depictured by Mr. Estevez. According to Kennedy, the contractors are slow to implement the RFID policy because of a delay in the Federal Acquisition Regulation enforcement and misunderstanding of requirements. Kennedy says that two big contractors, General Electric and Lockheed Martin, have started the process on a voluntarily basis as others are also welcome to do so. The author emphasizes that mainly passive, cheaper, tags are expected to be used by suppliers.

Kennedy outlines features of the slow implementation of the RFID policy. Among them, he indicates a lack of understanding outside DoD as well as inside the military and the cultural challenge that the radiofrequency technology faces. The other boundary for accomplishing this task, especially for small businesses, is financial upfront cost and uncertain payoff. The uncertainty flows from a lack of a uniform, worldwide adopted

RFID standard. According to Kennedy, the Department of Defense, in addition to commercial companies, such as Wal-Mart, joined EPCglobal, an organization developing this standard.

There are some more tangible examples of RFID usage in DoD. Lt. Col. Joseph Granata (USMC) discusses the United States Marine Corps lessons learned from the Operation Iraqi Freedom (OIF) in his two similar articles published in the Defense Transportation Journal[48] and Army Logistician.[49] He focuses, in particular, on a implementation of active RFID tags in the logistic supply chain, and he pictures using RFID for shipment tracking and management by the USMC.

Despite the fact that the Marines announced that the program was a success, the author discusses its failures at the bottom level of the supply chain. He underlines the urgency for implementing the radiofrequency technology to the entire logistic supply system. According to Granata, "once RFID-tagged shipments entered in-theater reports and airfields, and were disaggregated to move forward towards the war fighter, accountability was generally lost--and it was so fast."[50] In both articles, the author discuses the advantages of the RFID technology for the military logistic supply chain in achieving a better management as: "the ability to locate or redirect misroutes" and "prioritize shipments," in-transit visibility, mobility and "business-like efficiency." The additional, very important feature that can be gained is the confidence in a logistic system. This confidence helps planning to be better and it also helps to prevent redundant reorders.

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47 Harold Kennedy, "Contractors Urged to Comply with Smart-Tag Policy," National Defense, May 2005, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=874986261&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

48 Joseph Granata, "Materiel Tracking from WAREHOUSE to War Fighter: MARINE CORPS Logisticians Tackle the 'Last Tactical Mile'," Defense Transportation Journal, February 2005, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=804741611&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

49 Joseph Granata, "Tracking Materiel from Warehouse to Warfighter," Army Logistician, July/August 2005, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=879034211&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

50 Ibid.

Similarly to how Granata describes the Marines' RFID experiences, Fee and Schmack[51] picture the Army's experiences, starting in 1993. In addition to describing the history of usage RFID technology by the United States Army, they critique the current RFID application as a tool in providing "information on where equipment was, not where it is" and provide technical reasons for that state. As a solution to this imperfection, they show a prototype, called the Third Generation Radio Frequency Identification with Satellite Communications (3G RFID w/SATCOM), an integration of a radiofrequency technology, a global positioning system and satellite communications. The article compares current and future RFID capabilities.

Jeffery D. Fee and Alan Schmack are Army Logistics Transformation Agency's officers at Fort Belvoir. Jeffery Fee is the project leader for Third Generation Radio Frequency Identification with Satellite Communications.[52]

51 Jeffery Fee, Alan Schmack, "Improving RFID Technology," Army Logistician, March/April 2005, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=816929821&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

52 ProQuest, Author Affiliation, http://libproxy.nps.navy.mil/login?url=http://proquest.umi.com/pqdweb?did=816929821&Fmt=4&clientId=11969&RQT=309&VName=PQD (accessed September 16, 2005).

III. METHODOLOGY

A. MONTE CARLO SIMULATION

1. What is a Simulation?

According to Moore and Weatherford,[53] a simulation model is "a series of logical and mathematical operations that provides a measure of effectiveness for a particular set of values of the parameters and decisions." In other words, the simulation emulates the behavior of a real system.

2. Why it is Called Monte Carlo

A Monte Carlo simulation uses the generation of random variables, similarly to the generation of random numbers in casinos, as in the famous Monte Carlo casinos in Monaco.

> The random behavior in games of chance is similar to how Monte Carlo simulation selects variable values at random to simulate a model. When you roll a die, you know that either a 1, 2, 3, 4, 5, or 6 will come up, but you don't know which for any particular roll. It's the same with the variables that have a known range of values but an uncertain value for any particular time or event (e.g. interest rates, staffing needs, stock prices, inventory, phone calls per minute).[54]

3. Advantages of Monte Carlo Simulation

There are two main advantages of a simulation method obtaining the results of any system behavior. Simulation is used when a mathematical model is too complex to use. A mathematical method returns only the most likely result of a model. Simulation, on the other hand, provides the entire spectrum of outcomes and their likelihood.

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[53] Jeffrey H. Moore and Larry R. Weatherford, *Decision Modeling with Microsoft® Excel*, 6th ed. (New Jersey: Prentice Hall, 2001), 512.

[54] Decisioneering Webpage, http://www.decisioneering.com/monte-carlo-simulation.html (accessed March 12, 2006).

> Spreadsheet risk analysis uses both a spreadsheet model and simulation to automatically analyze the effect of varying inputs on outputs of the modeled system. One type of spreadsheet simulation is Monte Carlo simulation, which randomly generates values for uncertain variables over and over to simulate a model.[55]

The savings achieved due to ATOS implementation are subject to a number of variables, whose values are not known with certainty in advance. Rather, these variables, have different values which may be modeled as random variables with each variable described by a distribution of values. Therefore, using the Monte Carlo simulation allows estimate return on investment, when the saving factors are uncertain. The separate savings are random variables and their behavior can be described by a probability distribution.[56]

4. Crystal Ball

Crystal Ball, next to such applications as *@RISK*, *Risk+*, *PRICE model*, or *CRIMS/AHP*, is a computer tool which uses the Monte Carlo simulation. "*Crystal Ball* automatically calculates thousands of different 'what if' cases, saving the inputs and results of each calculation as individual scenarios. Analysis of these scenarios reveals … the range of possible outcomes, their probability of occurring"[57] and allows sensitivity analysis.

5. Understanding the Simulation

The user understanding of this simulation model is a key goal of this thesis. Without it, the model as well as this paper is useless. Chapter V discusses the model inputs, assumptions and simulation results.

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[55] Decisioneering Webpage, http://www.decisioneering.com/monte-carlo-simulation.html (accessed March 12, 2006).

[56] Jeffrey H. Moore and Larry R. Weatherford, *Decision Modeling with Microsoft® Excel, 6th ed.* (New Jersey: Prentice Hall, 2001), 462.

[57] Decisioneering webpage, http://www.decisioneering.com/crystal_ball/index.html (accessed March 12, 2006).

IV. MODELS

A. A-76 TRANSFORMATION AND ATOS IMPLEMENTATION MODEL

The A-76 and ATOS Implementation Model compares cumulative savings distributions resulting from A-76 transformation and ATOS implementation. The individual saving assumptions may have various ranges associated with them, which, in turn, depend on uncertainty assumptions. These probable savings are based on assumed improvements in each unit size category (small, medium and large) and in each of the following three cases

- A-76 transformation
- ATOS implementation in a transformed organization
- ATOS implementation in an untransformed organization

The *A-76 Transformation and ATOS Savings Model* is a prelude to the main ATOS ROI Model. This model focuses on two issues:

- Measuring the averaged results of A-76 transformation and ATOS implementation, in the entire organization, versus the measuring outcomes of these processes for a single unit or warehouse.
- Comparing the probable improvements in the munitions management process which result from the following
  - Accomplishing A-76 transformation, or
  - Implementing ATOS, or
  - Doing both of the above

This comparison provides a basis for understanding the probable savings bases on assumptions. This can help answer the question of how good ATOS outcomes should be to compete with A-76 transformation.

1. Model Assumptions

The assumptions used to drive the model follow.

1. On the basis of size, there are three categories of munitions management units in the Navy, large (NWS Seal Beach is an example of this size category), medium and small. Counting both East coast and West coast operations, the number of units is as follows:[58]

Size	Number of units
Small	10
Medium	15
Large	20

Table 3. Munitions Sites Size Division

2. Each unit in a particular type of category is the same size, so the savings (or efficiency improvement) percentages achieved within the category can be easily compared, averaged, or converted into dollars.

3. Each unit in a particular type of category runs the same type of operations so the probable savings (whether due to A-76 transformation, or to ATOS implementation) have the same probability distribution for all units in each category. The distribution is assumed to be triangular, characterized by three values: minimum value, likeliest and maximum value Table 5 presents the assumed savings and triangular distribution values.

Munitions Management Category	**Savings:**	**Due to A-76**	**Due to ATOS in not Transformed Organization**	**Due to ATOS in Transformed Organization**
Large	Minimum	28%	10%	5%
	Likeliest	33%	15%	10%
	Maximum	38%	20%	15%
Medium	Minimum	20%	10%	5%
	Likeliest	25%	15%	10%
	Maximum	30%	20%	15%
Small	Minimum	11%	10%	5%
	Likeliest	16%	15%	10%
	Maximum	21%	20%	15%

Table 4. A-76 Transformation and ATOS Implementation Model Savings Assumptions

[58] Mark Mentikov, personal interview, January 28, 2006.

Based on these assumptions, Crystal Ball can generate distributions of probable savings, for a single unit or each size category, as well as comparisons due to:

- A-76 transformation;
- ATOS implementation in an organization which has not undergone transformation;
- ATOS implementation in an organization which has undergone transformation.

2. Measuring Multiple versus Single Outcome

The savings achieved as a result of transformation or to ATOS implementation can be measured for each single unit or for all of them in a size category at the same time. When measuring a single unit savings, the results can be different than averaged savings. To prove that hypothesis, outcomes generated by Crystal Ball for ten large units are examined.

Three examples of savings distribution comparisons of the single unit versus the average unit output, in case of implementing, follow:

- A-76 transformation;
- ATOS in not transformed organization;
- A-76 transformation and, after that, ATOS into the large size category units.

The blue columns represent the savings achieved in a single large unit and the red columns represent the average savings for all large units. The tables following the charts contain some data concerning the distributions shown in those charts.

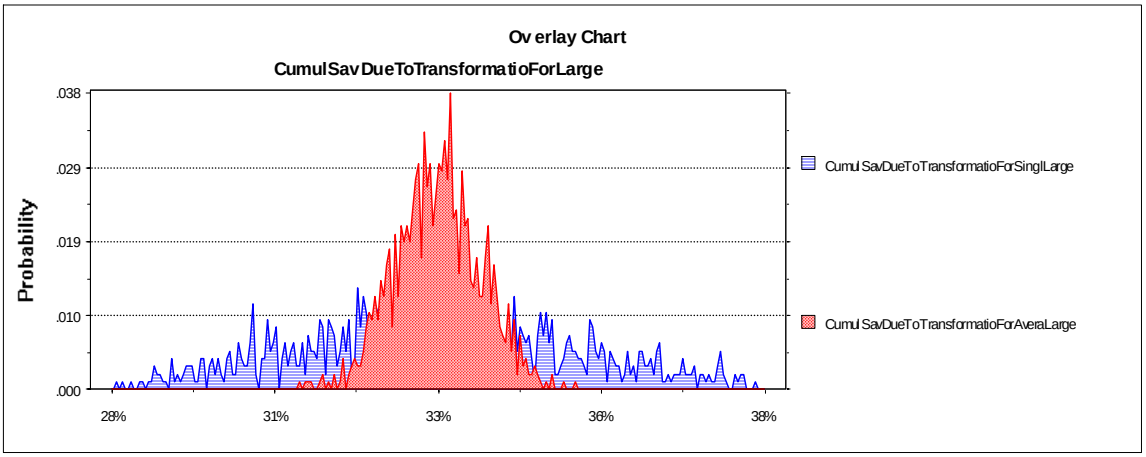


Figure 1. Single Versus Cumulative Savings due to Transformation for Large Units

Statistics	CumulSavDueToTransformatioForSinglLarge	CumulSavDueToTransformatioForAveraLarge
Trials	1000	1000
Mean	33%	33%
Standard Deviation	2%	1%
Range Minimum	28%	31%
Range Maximum	38%	35%
Range Width	10%	4%

Table 5. Single Versus Cumulative Savings Due to Transformation for Large Units

Figure 1 shows the saving distributions due to A-76 transformation. This figure demonstrates that the mean of distributions is the same when measuring single unit savings and average savings for all the large units. The single unit saving distribution, however, has a larger standard deviation and wider range than the average savings.

The following chart and table display results from the implementation of ATOS into the units which did not undergo the A-76 transformation. As in the previous case, the results for single unit and average savings have the same mean and the savings for single unit has a much greater standard deviation and range (10 versus 4%).

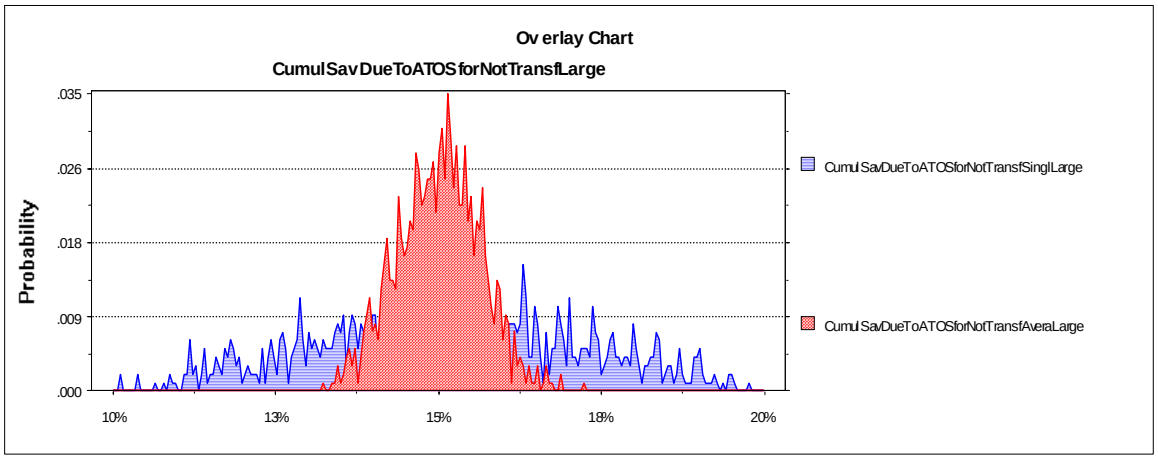


Figure 2. Single Versus Cumulative Savings Due to ATOS Implementation in Not Transformed Large Units

Statistics	CumulSavDueToATOSforNotTransf SinglLarge	CumulSavDueToATOSforNotTransf AveraLarge
Trials	1000	1000
Mean	15%	15%
Standard Deviation	2%	1%
Range Minimum	10%	13%
Range Maximum	20%	17%
Range Width	10%	4%

Table 6. Single Versus Cumulative Savings Due to ATOS Implementation in Not Transformed Large Units

The last figure shows the cumulative savings achieved due to the transformation and ATOS implementation. In this case, the difference between the savings distribution is even wider for the single unit than for the average large unit. It is 13% in comparison to 4% for the averaged savings for all ten large units.

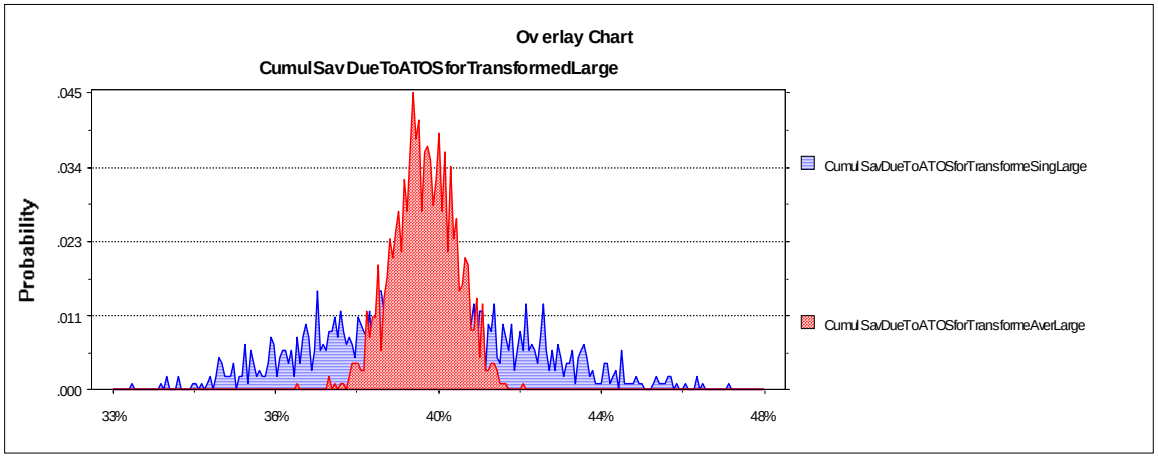


Figure 3. Single Versus Cumulative Savings Due to A-76 Transformation and ATOS Implementation Large Units

Statistics	CumulSavDueToATOSforTransformeSingLarge	CumulSavDueToATOSforTransformeAverLarge
Trials	1000	1000
Mean	40%	40%
Standard Deviation	2%	1%
Range Minimum	33%	37%
Range Maximum	47%	42%
Range Width	1000	1000

Table 7. Single Versus Cumulative Savings Due to A-76 Transformation and ATOS Implementation Large Units

A conclusion that might be drawn from the above comparisons is that making an organizational change can be more predictable for the entire enterprise than for a single unit. Even though the same assumptions are made concerning probable savings for each single unit, the average savings for all ten large units have less variation. Such a better prediction can be important in processes of decision making and planning.

For the greater number of units undergoing transformational change, the outcome variation will be further decreased and the standard deviation will shrink. Therefore, a change such as the implementation of ATOS should be done for all units.

3. ATOS versus A-76 Transformation

The second issue is a comparison of the probable improvement in munitions management that results from the following initiatives

- A-76 transformation
- ATOS implementation, or
- Both these processes.

This comparison is based on a model, which, with theoretical assumptions, assist in evaluating the probable savings. This comparison can help answer questions such as:

- How good ATOS outcomes should be to compete, in a cost-benefit sense, with A-76 transformation, or
- What is the most efficient way to introduce ATOS in the context of A-76 transformation?

In other words, if the Navy, in order to improve the operations of its munitions management units, instead of executing the transformation, were to implement ATOS into an organization which has not undergone the transformation, what is the trade-off between these two approaches?

An attempt will be made to examine this issue through the analytical lens of sensitivity analysis, that is, by changing the savings assumptions and observing the resulting cumulative outcomes. Since the goal is a relationship between transformation and ATOS implementation, the only assumption that will be changed is the value of the variable Savings Due to ATOS in not Transformed Organization. In each successive scenario, the probable savings to achieve in an organization which has not undergone the A-76 transformation will be increased by 5%. The value of the other two variables other two assumptions, Savings Due to A-76 and Savings Due to ATOS in Transformed Organization, will be not changed. The change will have two increments. That is, there will be three scenarios; Basic Scenario 1, Scenario 2 and Scenario 3.

Having learned from the above experience concerning the measurement of single or multiple outcomes, in further presentations, only average results for each unit size

category are included. The savings distribution are shown separately for the large, medium and small size of units. In each of the analyses, there are side by side presentations of probable savings distributions due to:

- the A-76 transformation (Result Savings For Average Large Unit, presented in red);
- the ATOS implementation in an organization which has not undergone the transformation;
- the ATOS implementation in an organization which has undergone the transformation.

a. Scenario 1

The first scenario adopted the same savings assumptions, as in the previous problem, which are presented in Table 8. It is assumed that the probable savings achieved due to A-76 transformation are different for different unit size categories. They follow triangular distributions and are highest for large units and smallest for small size category units. The other two savings categories are not different for the size types.

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Large	Minimum	28%	10%	5%
	Likeliest	33%	15%	10%
	Maximum	38%	20%	15%
Medium	Minimum	20%	10%	5%
	Likeliest	25%	15%	10%
	Maximum	30%	20%	15%
Small	Minimum	11%	10%	5%
	Likeliest	16%	15%	10%
	Maximum	21%	20%	15%

Table 8. A-76 Transformation and ATOS Implementation Model Scenario 1. Savings Assumptions

Large Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Large	Minimum	28%	10%	5%
	Likeliest	33%	15%	10%
	Maximum	38%	20%	15%

Table 9. A-76 Transformation and ATOS Implementation Model Scenario 1. Savings Assumptions for Large Units

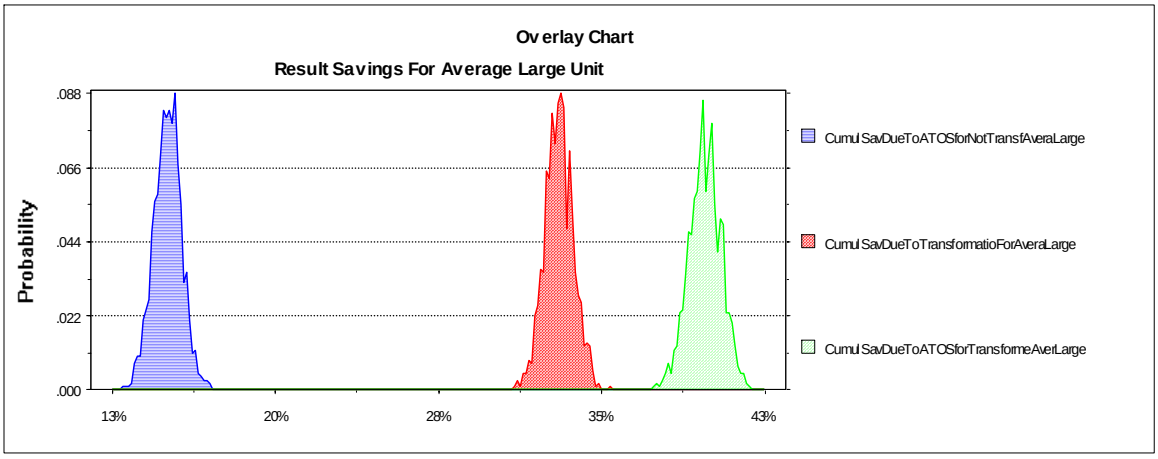


Figure 4. Scenario 1. Savings Distributions for Large Units

Statistics	Cumulative Saving due to A-76 for Lerge	Cumulat.Sav.due to ATOS NotTraLarge	CumulatSav. due to ATOS TransforLarge
Trials	1000	1000	1000
Mean	33%	15%	40%
Standard Deviation	1%	1%	1%
Range Minimum	31%	13%	37%
Range Maximum	35%	17%	42%

Table 10. Scenario 1. Savings Distributions for Large Units

The above analysis shows that the A-76 transformation savings and savings achieved due to ATOS implementation in not transformed units are the same as assumed. The cumulative savings achieved by ATOS implementation in transformed units, however, are better than the other two categories of savings.

Medium Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Medium	Minimum	20%	10%	5%
	Likeliest	25%	15%	10%
	Maximum	30%	20%	15%

Table 11. A-76 Transformation and ATOS Implementation Model Scenario 1. Savings Assumptions for Medium Units

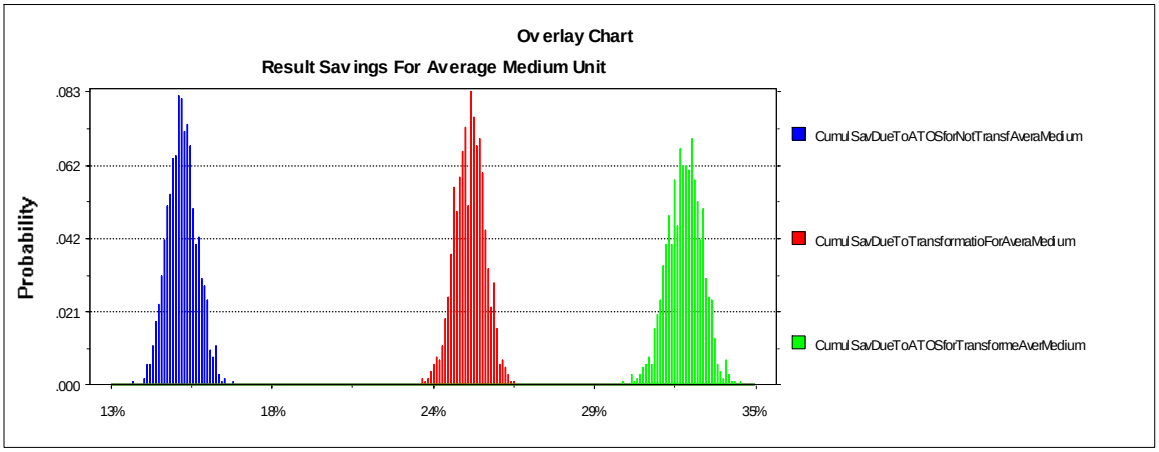


Figure 5. Scenario 1. Savings Distributions for Medium Units

Statistics	Cumulative Saving due to A-76 for Meduim	Cumulat.Sav.due to ATOS NotTraMedium	CumulatSav. due to ATOS TransforMedium
Trials	1000	1000	1000
Mean	25%	15%	33%
Standard Deviation	1%	1%	1%
Range Minimum	23%	13%	31%
Range Maximum	27%	17%	34%

Table 12. Scenario 1. Savings Distributions for Medium Units

For the medium size category, the savings tendency is similar to the large size category savings. Once again, the cumulative savings achieved thanks to the ATOS implementation in transformed units are better than the remaining categories savings.

Small Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Small	Minimum	11%	10%	5%
	Likeliest	16%	15%	10%
	Maximum	21%	20%	15%

Table 13. A-76 Transformation and ATOS Implementation Model Scenario 1. Savings Assumptions for Small Units

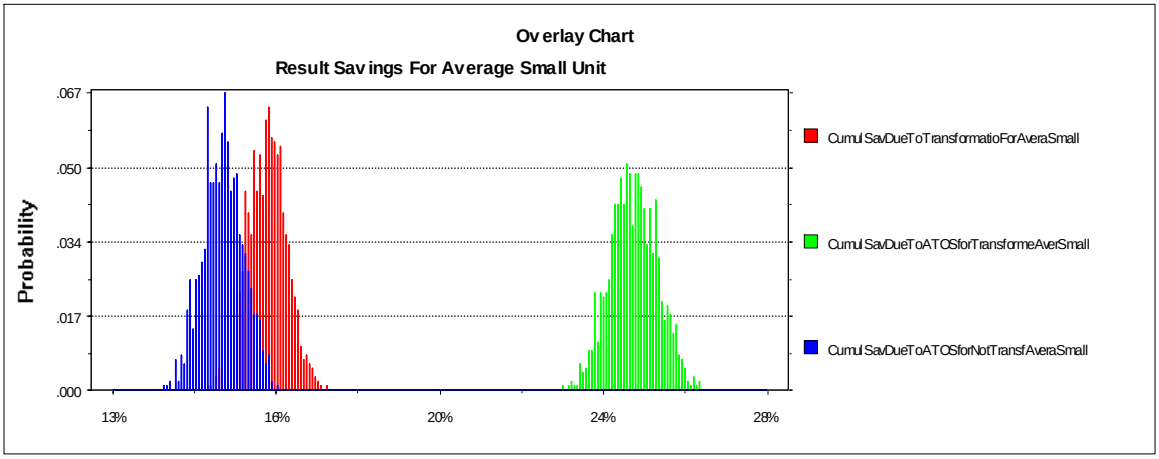


Figure 6. Scenario 1. Savings Distributions for Small Units

Statistics	CumulSavDueToTransformatioForAveraSmall	CumulSavDueToATOSforNotTransfAveraSmall	CumulSavDueToATOSforTransformeAverSmall
Trials	1000	1000	1000
Mean	16%	15%	24%
Standard Deviation	0%	0%	1%
Range Minimum	15%	14%	22%
Range Maximum	17%	16%	27%

Table 14. Scenario 1. Savings Distributions for Small Units

In small size category units, the cumulative savings due to the ATOS implementation achieve the highest again. Additionally, there is an overlapping of the distributions of the transformation savings and ATOS implementation savings in not transformed units. This overlapping is in accordance with the input assumptions of these savings, namely, triangular distributions as follows: TRIA (11%, 16%, 21%) and TRIA (10%, 15%, 20%)

b. Scenario 2

In the second scenario, the assumption is that the savings due to the A-76 transformation and the ATOS implementation in transformed organization are the same. The assumed savings resulting from the ATOS implementation in not transformed organizations are changed. They are 5% higher than in the first scenario and follow the TRIA (20%, 25%, 30%) triangular distribution for each of the size categories. This is done in order to find the point when the ATOS savings in not transformed units outweigh the transformation-only savings.

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Large	Minimum	28%	20%	5%
	Likeliest	33%	25%	10%
	Maximum	38%	30%	15%
Medium	Minimum	20%	20%	5%
	Likeliest	25%	25%	10%
	Maximum	30%	30%	15%
Small	Minimum	11%	20%	5%
	Likeliest	16%	25%	10%
	Maximum	21%	30%	15%

Table 15. A-76 Transformation and ATOS Implementation Model Scenario 2. Savings Assumptions

Large Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Large	Minimum	28%	20%	5%
	Likeliest	33%	25%	10%
	Maximum	38%	30%	15%

Table 16. A-76 Transformation and ATOS Implementation Model Scenario 2. Savings Assumptions for Large Units

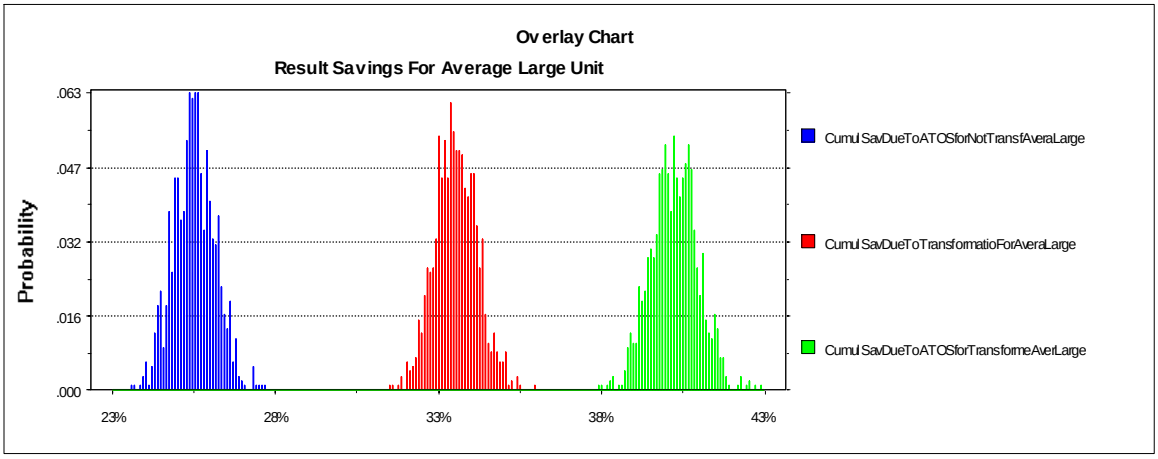


Figure 7. Scenario 2. Savings Distributions for Large Units

Statistics	CumulSavDueToTransformatioForAveraLarge	CumulSavDueToATOSforNotTransfAveraLarge	CumulSavDueToATOSforTransformeAverLarge
Trials	1000	1000	1000
Mean	33%	25%	40%
Standard Deviation	1%	1%	1%
Range Minimum	31%	23%	37%
Range Maximum	36%	27%	42%

Table 17. Scenario 2. Savings Distributions for Large Units

In this scenario, for the large size category, the savings tendency is similar to the large size category savings. The ATOS savings in not transformed units are still the lowest. The cumulative savings achieved due to the ATOS implementation in transformed units are better than the remaining categories savings.

Medium Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Medium	Minimum	20%	20%	5%
	Likeliest	25%	25%	10%
	Maximum	30%	30%	15%

Table 18. A-76 Transformation and ATOS Implementation Model Scenario 2. Savings Assumptions for Medium Units

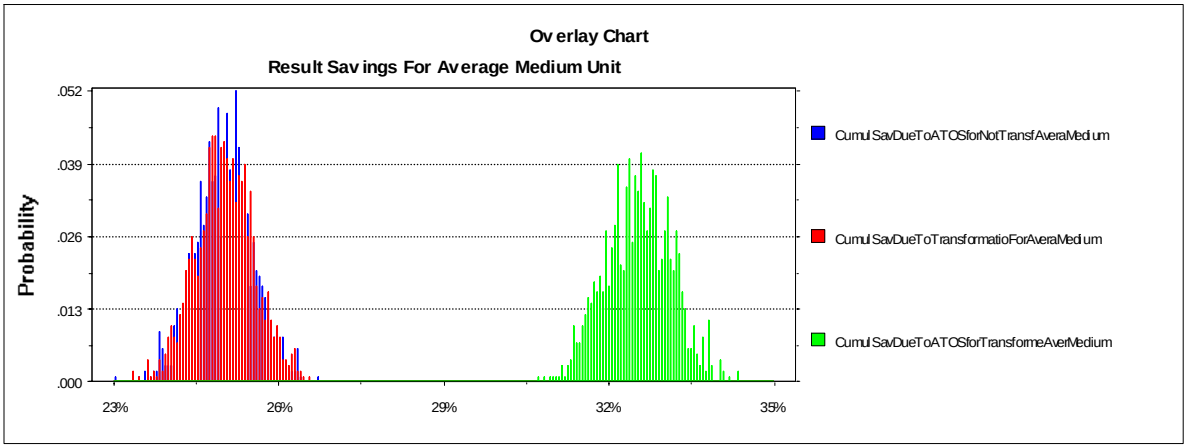


Figure 8. Scenario 2. Savings Distributions for Medium Units

Statistics	CumulSavDueToTransformatioForAveraMedium	CumulSavDueToATOSforNotTransfAveraMedium	CumulSavDueToATOSforTransformeAverMedium
Trials	1000	1000	1000
Mean	25%	25%	33%
Standard Deviation	1%	1%	1%
Range Minimum	23%	23%	31%
Range Maximum	27%	27%	35%

Table 19. Scenario 2. Savings Distributions for Medium Units

For medium size units, the savings due to the A-76 transformation and the savings due to the ATOS implementation in not transformed units are the same. The cumulative savings achieved after the ATOS implementation in transformed units are better than the other two.

Small Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Small	Minimum	11%	20%	5%
	Likeliest	16%	25%	10%
	Maximum	21%	30%	15%

Table 20. A-76 Transformation and ATOS Implementation Model Scenario 2. Savings Assumptions for Small Units

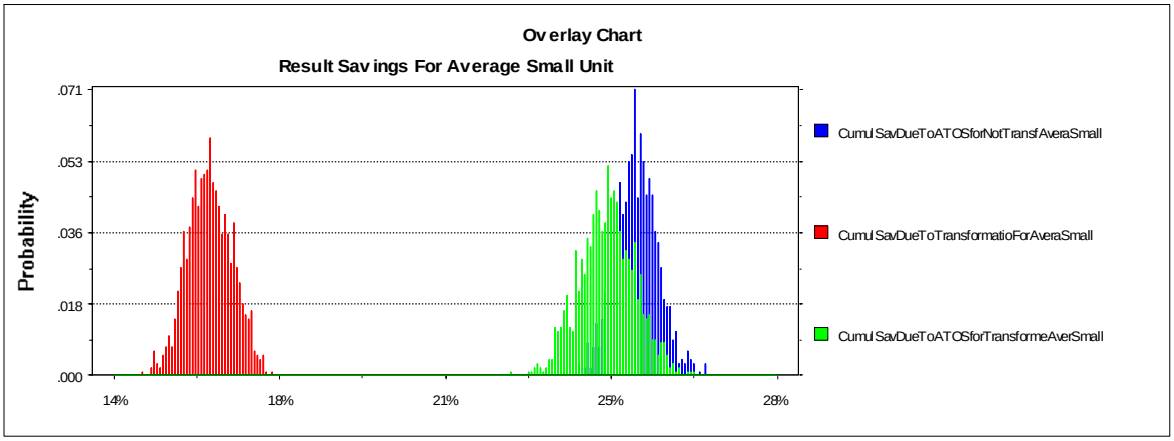


Figure 9. Scenario 2. Savings Distributions for Small Units

Statistics	CumulSavDueToTransformatioForAveraSmall	CumulSavDueToATOSforNotTransfAveraSmall	CumulSavDueToATOSforTransformeAverSmall
Trials	1000	1000	1000
Mean	16%	25%	24%
Standard Deviation	0%	0%	1%
Range Minimum	15%	24%	22%
Range Maximum	17%	27%	26%

Table 21. Scenario 2. Savings Distributions for Small Units

For small units, in this scenario, it is assumed the ATOS savings in not transformed units, which follow the TRIA (20%, 25%, 30%) triangular distribution, are much higher than the transformation only savings, TRIA (11%, 16%, 21%). Also assumed is that the ATOS implementation would improve the efficiency in transformed units for another TRIA (5%, 10%, 15%). Under these assumptions, the resulting savings due to the ATOS implementation in not transformed units are even slightly better than the savings resulting from the ATOS implementation in transformed units.

c. Scenario 3

The third scenario continues the previous analyses and the assumption is that the distribution for savings achieved due to the ATOS implementation in units, which have not undergone transformation is as good as the TRIA (25%, 30%, 35%) triangular distribution.

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Large	Minimum	28%	25%	5%
	Likeliest	33%	30%	10%
	Maximum	38%	35%	15%
Medium	Minimum	20%	25%	5%
	Likeliest	25%	30%	10%
	Maximum	30%	35%	15%
Small	Minimum	11%	25%	5%
	Likeliest	16%	30%	10%
	Maximum	21%	35%	15%

Table 22. A-76 Transformation and ATOS Implementation Model Scenario 3. Savings Assumptions

Large Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Large	Minimum	28%	25%	5%
	Likeliest	33%	30%	10%
	Maximum	38%	35%	15%

Table 23. A-76 Transformation and ATOS Implementation Model Scenario 3. Savings Assumptions for Large Units

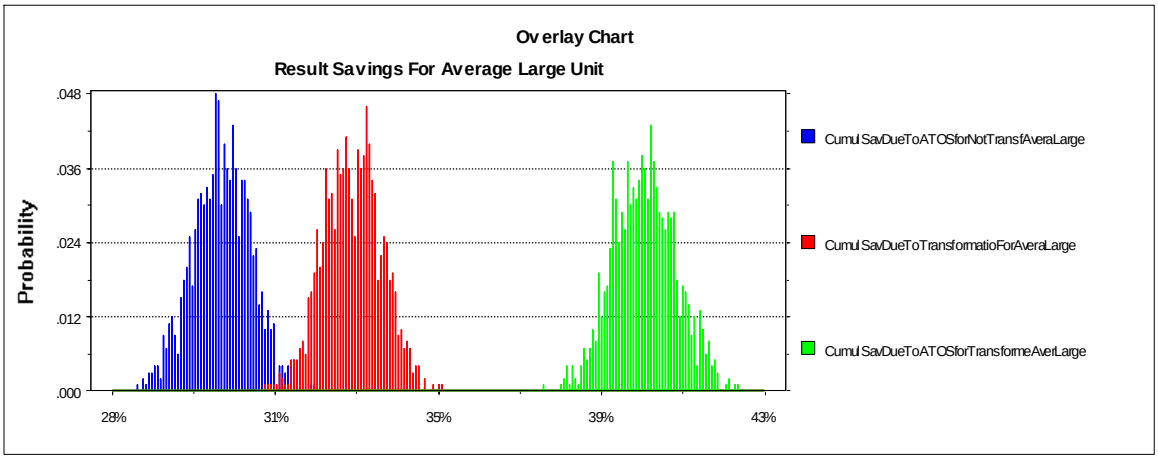


Figure 10. Scenario 3. Savings Distributions for Large Units

Statistics	CumulSavDueToTransformatioForAveraLarge	CumulSavDueToATOSforNotTransfAveraLarge	CumulSavDueToATOSforTransformeAverLarge
Trials	1000	1000	1000
Mean	33%	30%	40%
Standard Deviation	1%	1%	1%
Range Minimum	31%	28%	38%
Range Maximum	35%	32%	42%

Table 24. Scenario 3. Savings Distributions for Large Units

As seen above, the outcome for large units is similar to the results from the previous two scenarios. The ATOS-only savings are the lowest and the combination of the A-76 transformation and the ATOS implementation brings the best effect again.

Medium Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Medium	Minimum	20%	25%	5%
	Likeliest	25%	30%	10%
	Maximum	30%	35%	15%

Table 25. A-76 Transformation and ATOS Implementation Model Scenario 3. Savings Assumptions for Medium Units

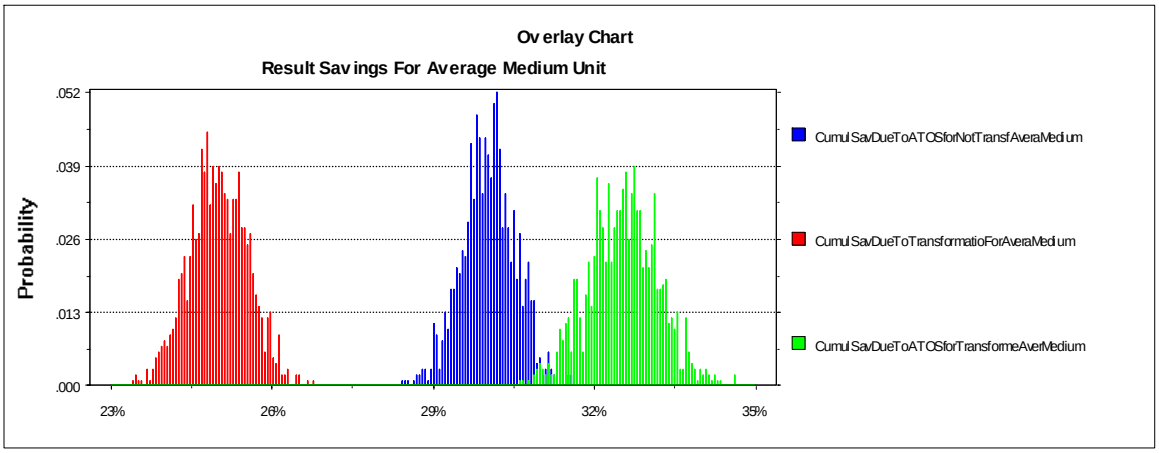


Figure 11. Scenario 3. Savings Distributions for Medium Units

Statistics	CumulSavDueToTransformatioForAveraMedium	CumulSavDueToATOSforNotTransfAveraMedium	CumulSavDueToATOSforTransformeAverMedium
Trials	1000	1000	1000
Mean	25%	30%	33%
Standard Deviation	1%	1%	1%
Range Minimum	24%	28%	31%
Range Maximum	27%	32%	35%

Table 26. Scenario 3. Savings Distributions for Medium Units

In this case, the savings achieved due to ATOS in not transformed units are better than the savings due to the A-76 transformation. The transformation and then the ATOS implementation proved to be better again.

4. Small Units

Munitions Management Category	Savings:	Due to A-76	Due to ATOS in not Transformed Organization	Due to ATOS in Transformed Organization
Small	Minimum	11%	25%	5%
	Likeliest	16%	30%	10%
	Maximum	21%	35%	15%

Table 27. A-76 Transformation and ATOS Implementation Model Scenario 3. Savings Assumptions for Small Units

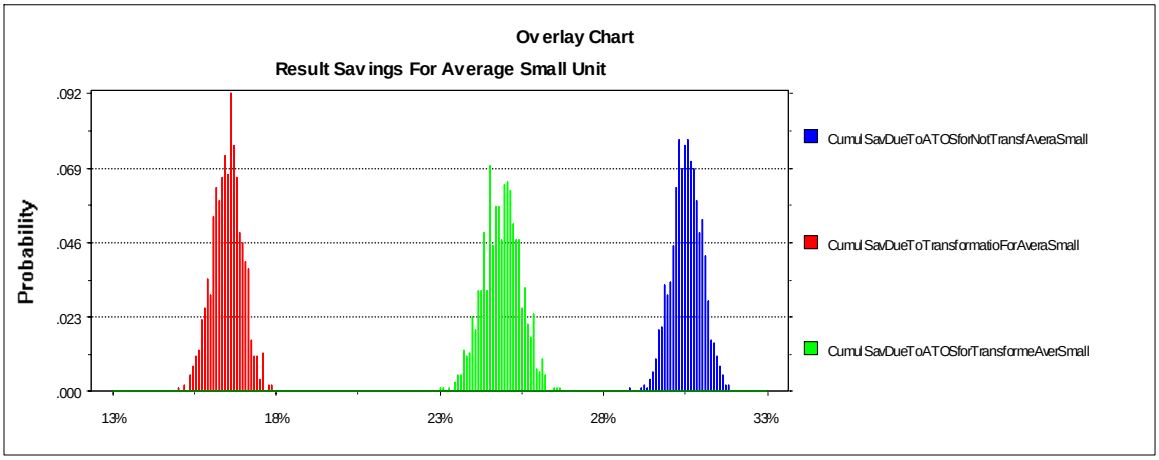


Figure 12. Scenario 3. Savings Distributions for Medium Units

Statistics	CumulSavDueToTransformatioForAveraSmall	CumulSavDueToATOSforNotTransfAveraSmall	CumulSavDueToATOSforTransformeAverSmall
Trials	1000	1000	1000
Mean	16%	30%	24%
Standard Deviation	0%	0%	1%
Range Minimum	15%	29%	23%
Range Maximum	18%	31%	27%

Table 28. Scenario 3. Savings Distributions for Medium Units

The assumption in this case is that the transformation alone is not very effective and the additional savings probable to achieve due to ATOS in transformed organization are much lower than those in not transformed organizations. Under these unrealistic rather assumptions, even combining the transformation and the ATOS savings in transformed units are worse than the ATOS saving in not transformed.

5. Conclusions

This methodology makes it possible to analyze either:

- across the size categories, or
- across the transformed versus not-transformed units.

From the three scenarios, it could be concluded that implementing ATOS always occurs in transformed organizations but not in transformed ones.

B. ATOS ROI

The return on investment model is part of this thesis. The structure of the model is based upon the return on investment definition and the U.S. Navy munitions management generic structure and main operating cost categories. All these elements are further described in this chapter.

The model is created in Microsoft Excel and works in Crystal Ball, which allows the use of Monte Carlo simulation. The Monte Carlo simulation is very helpful because of many uncertainties related to savings prediction, or even actual munitions management cost assessment. The model allows forecasting of return on investment in the context of probability distributions, and, in that way, it can be used as a decision making support tool.

The description of the Excel model follows this introduction, while the full description of the Excel ROI Model is placed at the end of this chapter.

1. Return on Investment Definition and Model

> Return on Investment (ROI) is a straightforward financial tool that measures the economic return of a project or investment. ROI measures the effectiveness of the investment by calculating how many times the net benefits (benefits from investment minus initial and ongoing costs)

recover the original investment. ROI has become one of the most popular metrics used to understand, evaluate and compare the value of different investment options.[59]

In the financial analysis literature, there are multiple metrics that can be used for the return on investment computation. The metric adapted in this paper is the ratio of the overall first year's project profit over the project investment. Figure 13 shows the top-level view of the ATOS ROI.

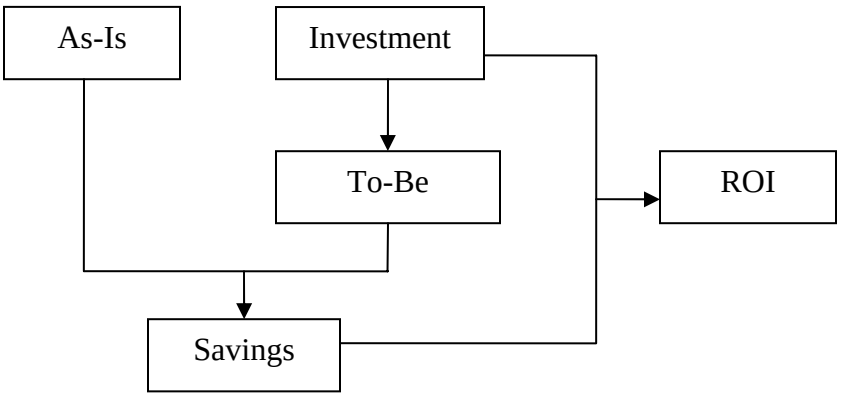


Figure 13. ROI Model

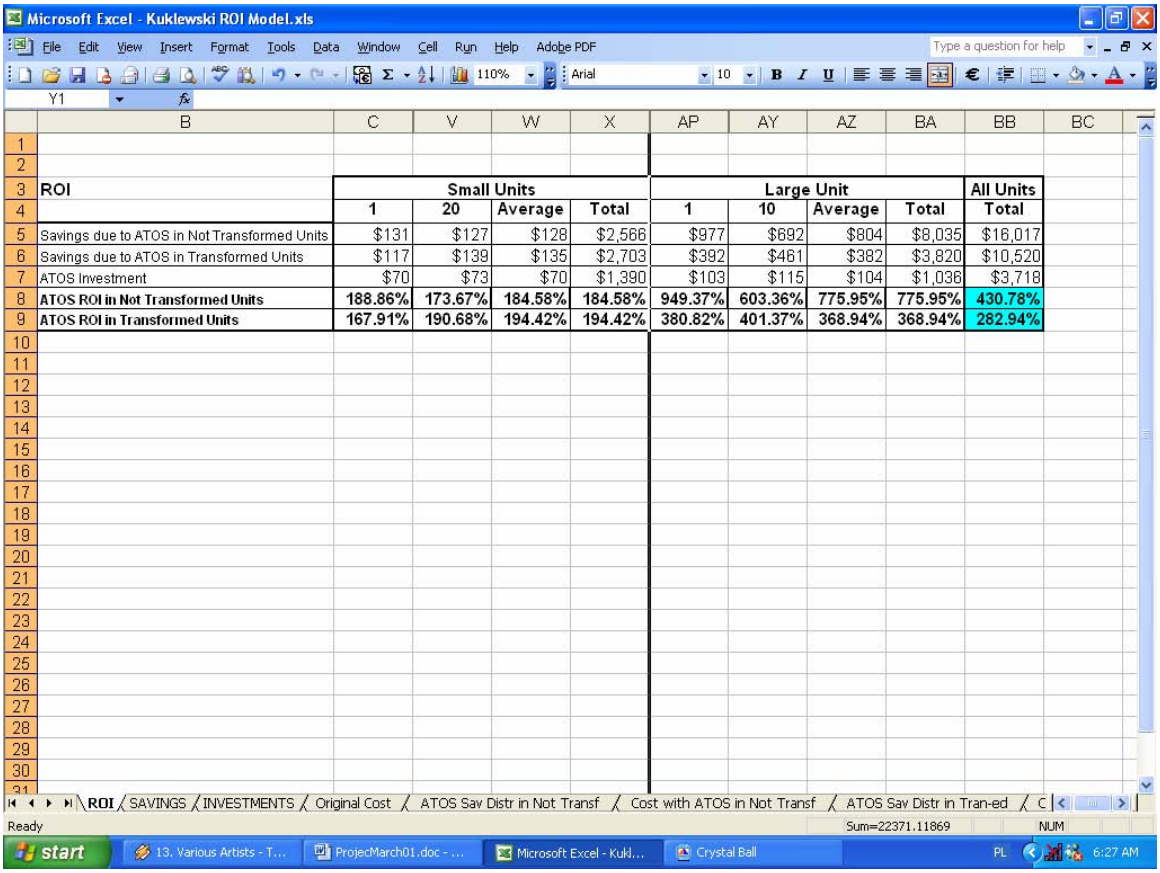
- The As-Is box represents the current structure of the munitions management process and the operating cost of that structure. The Investment box represents the costs of the ATOS implementation.
- The To-Be box represents the structure of the munitions management with ATOS implemented, and the operating costs associated with that transaction.
- The Savings represents the difference between the As-Is and To-Be costs, and ROI represents the return on investment in a sense described in the box below.

ROI= Savings/Investment

Figure 14. ROI Definition

[59] http://www.odellion.com/pages/online%20community/ROI/financialmodels_roi_definition.htm (accessed February 19, 2006).

– The Excel model is based on the above model, with each of these parts placed in one or more separate spreadsheets. The overarching spreadsheet, containing the return on investment result forecast cells, is called ROI, and is presented in Figure 15.



Microsoft Excel - Kuklewski ROI Model.xls

	ROI	Small Units				Large Unit				All Units
		1	20	Average	Total	1	10	Average	Total	Total
5	Savings due to ATOS in Not Transformed Units	$131	$127	$128	$2,566	$977	$692	$804	$8,035	$16,017
6	Savings due to ATOS in Transformed Units	$117	$139	$135	$2,703	$392	$461	$382	$3,820	$10,520
7	ATOS Investment	$70	$73	$70	$1,390	$103	$115	$104	$1,036	$3,718
8	**ATOS ROI in Not Transformed Units**	**188.86%**	**173.67%**	**184.58%**	**184.58%**	**949.37%**	**603.36%**	**775.95%**	**775.95%**	**430.78%**
9	**ATOS ROI in Transformed Units**	**167.91%**	**190.68%**	**194.42%**	**194.42%**	**380.82%**	**401.37%**	**368.94%**	**368.94%**	**282.94%**

Figure 15. ROI Spreadsheet

2. As-Is Description

This part describes the current operating cost of the munitions management process, represented in the Excel model as Original Cost. In this analysis, it is also called As-Is. The model includes the operating cost of the onshore munitions management units, the munitions magazines. In order to accurately systemize and estimate the actual *As-Is* cost, it is necessary to take a closer look at the munitions management unit activities in the Seal Beach Naval Weapon Station. The process charts which show the notional munitions management unit activities appear in Appendix A. The process charts include the actual (*As-Is*) and the targeted (*To-Be*) cost.

The US Navy munitions magazines fall under the Pacific or Atlantic Fleet area of responsibility, and there are three size warehouse categories: large, medium and large. They are distinguished due to the different size, type and cost of operations. Magazines may also be distinguished by their "A-76" status. Some of the magazines went through the Office of Management and Budget (OMB) A-76 transformation process and, as discovered, they have significantly improved their operations. The Naval Weapon Station Seal Beach is an example of a large A-76 transformed organization.

Table 29, based on an interview with Mr. Mark Mentikov,[60] presents the number of munitions management units in each category.

		Small	**Medium**	**Large**
Pacific Fleet Area of Responsibility	Transformed	0	0	5
	Not – transformed	8	12	2
	All	8	12	7
Atlantic Fleet Area of Responsibility	Transformed	0	0	0
	Not – transformed	12	3	3
	All	12	3	3
Total		**20**	**15**	**10**

Table 29. Munitions Management Units

The total numbers of magazines in each size category is the baseline for the ROI model. It contains the same number of units and assumes that they are not transformed.

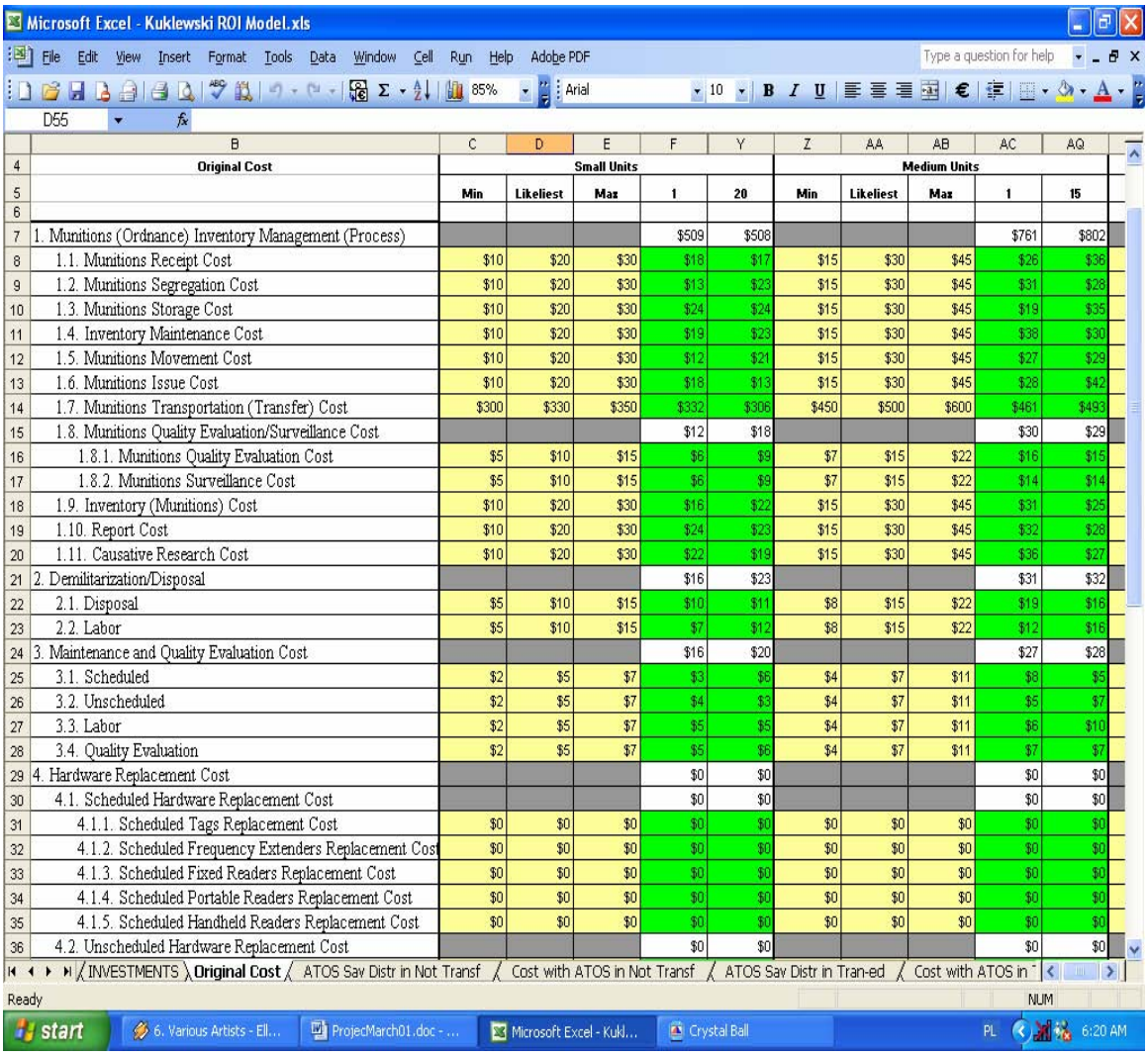
The *Original Cost* spreadsheet in the Excel model in Figure 16, includes the operating and support, as well as environmental costs of the not transformed munitions management units. Table 30 lists these costs.

60 Mark Mentikov, personal interview, January 28, 2006.

1. Munitions (Ordnance) Inventory Management (Process) Cost
1.1. Munitions Receipt Cost
1.2. Munitions Segregation Cost
1.3. Munitions Storage Cost
1.4. Inventory Maintenance Cost
1.5. Munitions Movement Cost
1.6. Munitions Issue Cost
1.7. Munitions Transportation (Transfer) Cost
1.8. Munitions Quality Evaluation/Surveillance Cost
1.8.1. Munitions Quality Evaluation Cost
1.8.2. Munitions Surveillance Cost
1.9. Inventory (Munitions) Cost
1.10. Report Cost
1.11. Causative Research Cost
2. Demilitarization/Disposal
2.1. Disposal
2.2. Labor
3. Maintenance and Quality Evaluation Cost
3.1. Scheduled
3.2. Unscheduled
3.3. Labor
3.4. Quality Evaluation
4. Hardware Replacement Cost
4.1. Scheduled Hardware Replacement Cost
4.1.1. Scheduled Tags Replacement Cost
4.1.2. Scheduled Frequency Extenders Replacement Cost
4.1.3. Scheduled Fixed Readers Replacement Cost
4.1.4. Scheduled Portable Readers Replacement Cost
4.1.5. Scheduled Handheld Readers Replacement Cost
4.2. Unscheduled Hardware Replacement Cost
4.2.1. Unscheduled Tags Replacement Cost
4.2.2. Unscheduled Frequency Extenders Replacement Cost
4.2.3. Unscheduled Fixed Readers Replacement Cost
4.2.4. Unscheduled Portable Readers Replacement Cost
4.2.5. Unscheduled Handheld Readers Replacement Cost
5. Environmental Cost
5.1. Mishap Cost
5.1.1. Lost Magazine Cost
5.1.2. Lost Munitions Cost
5.1.3. Clean-Up Cost
5.2. Quality Evaluation Cost
5.2.1. Munitions Cost
5.2.2. Personnel Cost
5.3. Mishandling and Dropped Ordnance Cost
5.4. Corrosion Maintenance Cost
5.5. In-Transit Visibility Cost

Table 30. Operating & Support and Environmental Costs Distribution

The list is consistent throughout the entire model. Thus, other operating and support cost and environmental cost spreadsheets, such as *Cost with ATOS in Not Transf* and *Cost with ATOS in Tran-ed*, contain the same cost categories.



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	B	C	D	E	F	Y	Z	AA	AB	AC	AQ
4	Original Cost	Small Units					Medium Units				
5		Min	Likeliest	Max	1	20	Min	Likeliest	Max	1	15
6											
7	1. Munitions (Ordnance) Inventory Management (Process)				$509	$508				$761	$802
8	1.1. Munitions Receipt Cost	$10	$20	$30	$18	$17	$15	$30	$45	$26	$36
9	1.2. Munitions Segregation Cost	$10	$20	$30	$13	$23	$15	$30	$45	$31	$28
10	1.3. Munitions Storage Cost	$10	$20	$30	$24	$24	$15	$30	$45	$19	$35
11	1.4. Inventory Maintenance Cost	$10	$20	$30	$19	$23	$15	$30	$45	$38	$30
12	1.5. Munitions Movement Cost	$10	$20	$30	$12	$21	$15	$30	$45	$27	$29
13	1.6. Munitions Issue Cost	$10	$20	$30	$18	$13	$15	$30	$45	$28	$42
14	1.7. Munitions Transportation (Transfer) Cost	$300	$330	$350	$332	$306	$450	$500	$600	$461	$493
15	1.8. Munitions Quality Evaluation/Surveillance Cost				$12	$18				$30	$29
16	1.8.1. Munitions Quality Evaluation Cost	$5	$10	$15	$6	$9	$7	$15	$22	$16	$15
17	1.8.2. Munitions Surveillance Cost	$5	$10	$15	$6	$9	$7	$15	$22	$14	$14
18	1.9. Inventory (Munitions) Cost	$10	$20	$30	$16	$22	$15	$30	$45	$31	$25
19	1.10. Report Cost	$10	$20	$30	$24	$23	$15	$30	$45	$32	$28
20	1.11. Causative Research Cost	$10	$20	$30	$22	$19	$15	$30	$45	$36	$27
21	2. Demilitarization/Disposal				$16	$23				$31	$32
22	2.1. Disposal	$5	$10	$15	$10	$11	$8	$15	$22	$19	$16
23	2.2. Labor	$5	$10	$15	$7	$12	$8	$15	$22	$12	$16
24	3. Maintenance and Quality Evaluation Cost				$16	$20				$27	$28
25	3.1. Scheduled	$2	$5	$7	$3	$6	$4	$7	$11	$8	$5
26	3.2. Unscheduled	$2	$5	$7	$4	$3	$4	$7	$11	$5	$7
27	3.3. Labor	$2	$5	$7	$5	$5	$4	$7	$11	$6	$10
28	3.4. Quality Evaluation	$2	$5	$7	$5	$6	$4	$7	$11	$7	$7
29	4. Hardware Replacement Cost				$0	$0				$0	$0
30	4.1. Scheduled Hardware Replacement Cost				$0	$0				$0	$0
31	4.1.1. Scheduled Tags Replacement Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
32	4.1.2. Scheduled Frequency Extenders Replacement Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
33	4.1.3. Scheduled Fixed Readers Replacement Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
34	4.1.4. Scheduled Portable Readers Replacement Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
35	4.1.5. Scheduled Handheld Readers Replacement Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
36	4.2. Unscheduled Hardware Replacement Cost				$0	$0				$0	$0

Figure 16. Original Cost Spreadsheet

3. Investment

According to Kratzer:

The ATOS infrastructure at a Munitions Management facility will consume the biggest portion of the investment funding due to the amount of equipment/software, installation cost, and personnel training needed for

> the newly fielded system. Of course, the number of munitions magazines and the number of munitions in a facility will dictate the true implementation cost.[61]

The number of munitions is certainly crucial for the investment expenses. Based on conclusions from the analysis in Chapter V.A.1. Measuring Multiple versus Single Outcome, the number of units mentioned in Chapter V.A.1. Model Assumptions, can be included, which is 10 large units, 15 medium and 20 small units. In this model, the investment is divided into the categories presented in Table 31.

1. Hardware Cost
1.1. RFID Readers Cost
1.1.1. Fixed RFID Readers Cost
1.1.2. Portable RFID Readers Cost
1.1.3. Handheld RFID Readers Cost
1.2. Frequency extenders Cost
2. Hardware Installation Cost
3. RFID Tag Cost
4. Software Installation Cost
5. Long-Range Communication Link Cost
5.1. Equipment Long-Range Communication Link Cost
5.2. Installation Long-Range Communication Link Cost
6. Personnel Training Cost
7. Modeling Environmental Cost
8. Other Costs

Table 31. ATOS Investment Distribution

The investment costs used in the model are based on Kratzer's estimate used in the ROI analysis for a notional five munitions magazine.[62] They are just notional numbers and should be further investigate when using the model.

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61 Gadala E. Kratzer, *A Methodological Approach for Conducting a Business Case Analysis for the Advanced Technology Ordnance Surveillance (ATOS) Advanced Concept Technology Demonstration (ACTD)*, (Monterey: Naval Postgraduate School, 2005), http://library.nps.navy.mil/uhtbin/cgisirsi/kgu4naLj0f/SIRSI/170430048/523/9572 (accessed March 15, 2006), 33.

62 Gadala E. Kratzer, *A Methodological Approach for Conducting a Business Case Analysis for the Advanced Technology Ordnance Surveillance (ATOS) Advanced Concept Technology Demonstration (ACTD)*, (Monterey: Naval Postgraduate School, 2005), http://library.nps.navy.mil/uhtbin/cgisirsi/kgu4naLj0f/SIRSI/170430048/523/9572 (accessed March 15, 2006), 45.

The investment heavily depends on the RFID technology generation implemented. As the Turbo CADS 2005 exercise shows,[63] the second generation (Gen2) technology does not require heavy, fixed infrastructure. Things such as frequency extenders are not required for these Gen2 networking tags, and there are fewer RFID readers required. The hardware installation cost is also significantly lower in the case of Gen2 RFID implementation.

Analyzing the ATOS investment, one should also investigate a possible correlation between the investment and transformation effect. It might be the case that the transformed units require less investment due to the efficiency level already achieved.

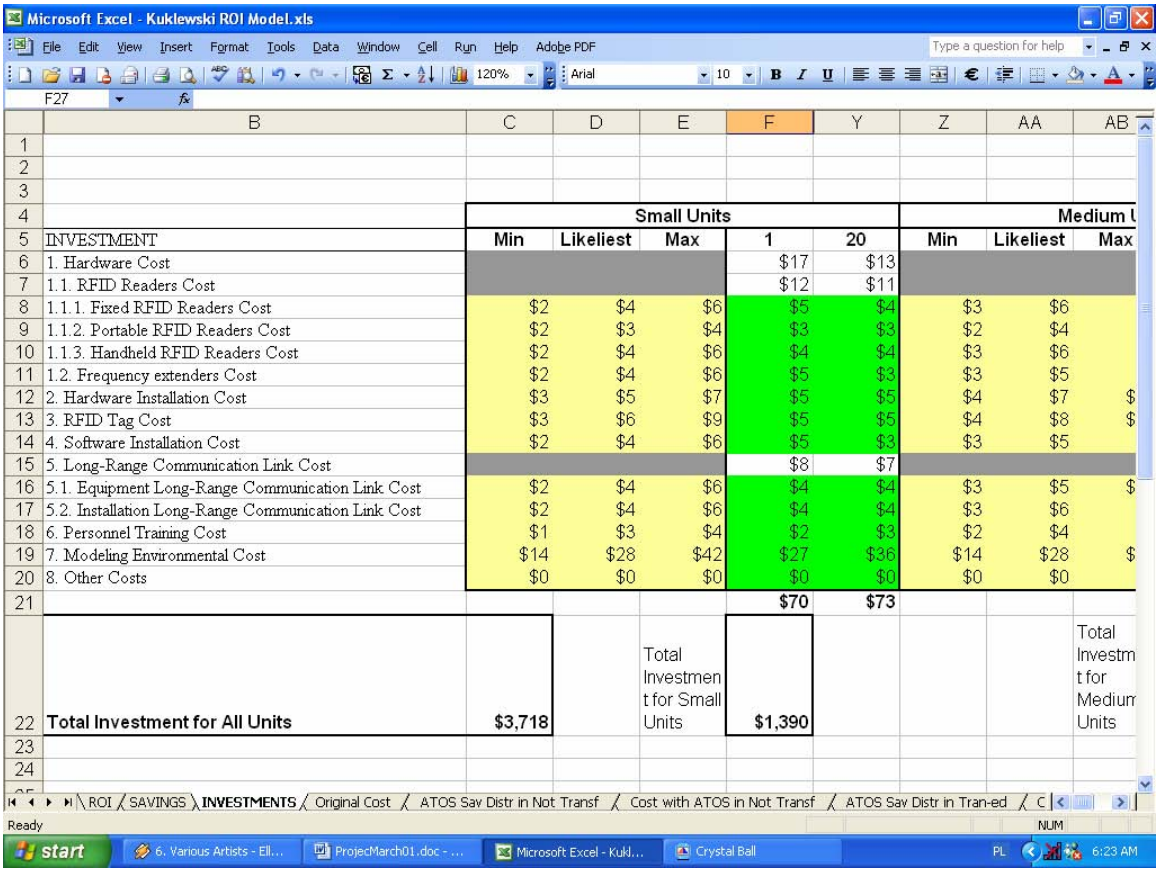


Figure 17. Investment Spreadsheet

63 Mark Mentikov, *Anchoring Sea Enterprise: Planning for the Successful Implementation of Radio Frequency Identification (RFID),* Pacific Fleet Ordnance AIT Program, 9.

4. Savings Description

The savings description is probably the most important part of the model. It is a factor that strongly determines the end result of the model - the return on investment.

The projected savings distribution, possibly due to the ATOS implementation, depends on:

- whether the unit has undergone the A-76 transformation process or not;
- the size category of the unit.

The A-76 transformation results in 33 improvements in operations. Therefore, assume that the magazines, which already are transformed, will achieve less improvement than the not-transformed units.

Implementation of the RFID technology brings labor savings:

- some processes, for instance segregation, can be eliminated;
- some processes can be transferred on-shore which enables the Distance Support Concept. It means that crews, which are minimally staffed, may focus on an actual mission;
- some processes may be improved:
  - Munitions reporting;
  - Reclassification of munitions;
  - Weekly samplings;
  - Condition code changing – Naval Ammunition Reclassification (NAR)
  - Receipt – diminished to visual inspection.

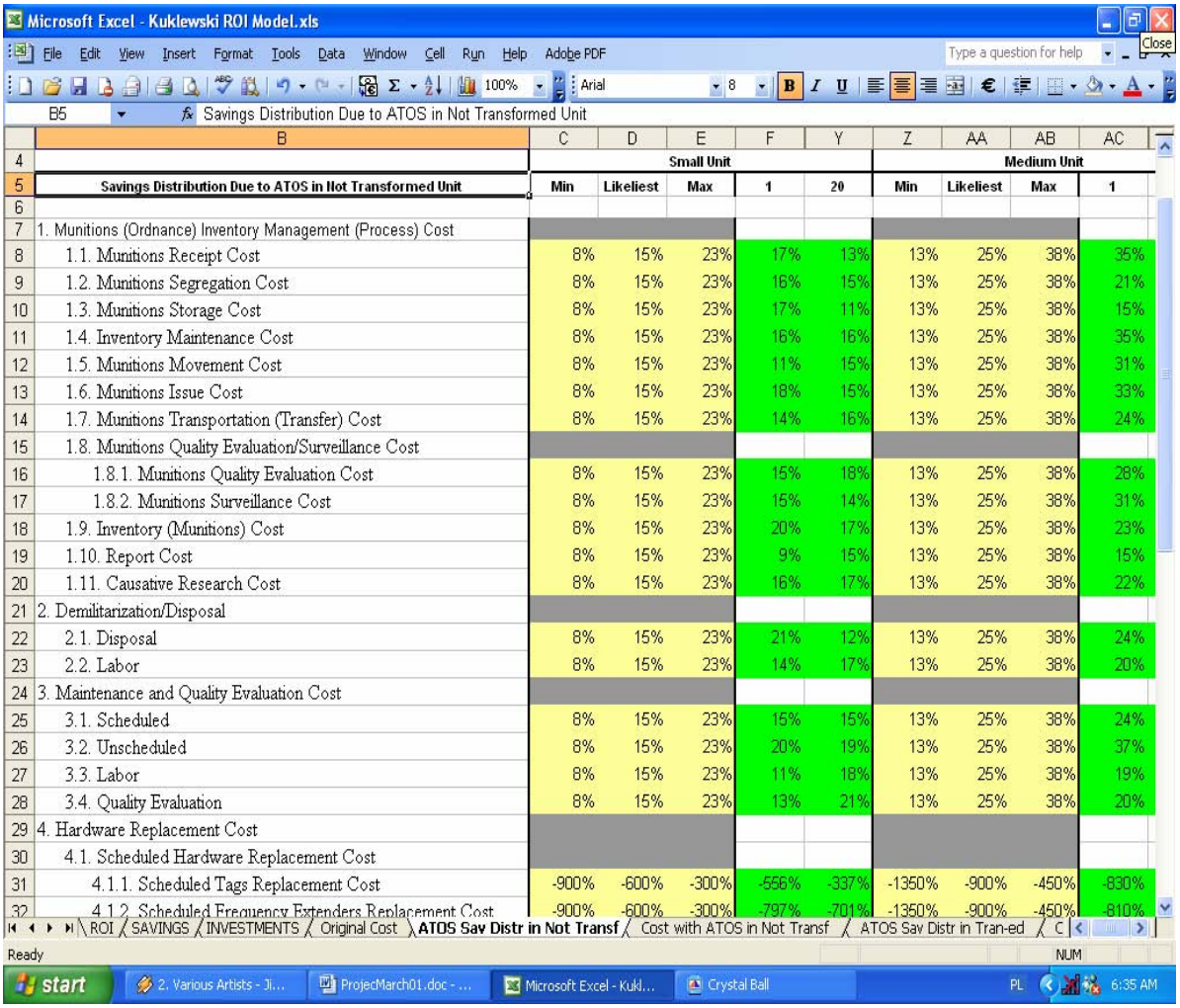
For further insight into the munitions management processes, see Appendix A.

In the ATOS ROI Excel model, the savings assumptions are defined in the following spreadsheets:

- ATOS Sav Distr in Not Transf – for savings distribution due to the ATOS implementation in the units which have not undergone the A-76 transformation; see Figure 18;

– ATOS Sav Distr in Tran-ed - for savings distribution due to the ATOS implementation in the units which have undergone the A-76 transformation; see Figure 19;

– There is also Transf Sav Distr spreadsheet for the A-76 transformation assumptions; see Figure 20.



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B5 Savings Distribution Due to ATOS in Not Transformed Unit

	B	C	D	E	F	Y	Z	AA	AB	AC
4		Small Unit					Medium Unit			
5	Savings Distribution Due to ATOS in Not Transformed Unit	Min	Likeliest	Max	1	20	Min	Likeliest	Max	1
6										
7	1. Munitions (Ordnance) Inventory Management (Process) Cost									
8	1.1. Munitions Receipt Cost	8%	15%	23%	17%	13%	13%	25%	38%	35%
9	1.2. Munitions Segregation Cost	8%	15%	23%	16%	15%	13%	25%	38%	21%
10	1.3. Munitions Storage Cost	8%	15%	23%	17%	11%	13%	25%	38%	15%
11	1.4. Inventory Maintenance Cost	8%	15%	23%	16%	16%	13%	25%	38%	35%
12	1.5. Munitions Movement Cost	8%	15%	23%	11%	15%	13%	25%	38%	31%
13	1.6. Munitions Issue Cost	8%	15%	23%	18%	15%	13%	25%	38%	33%
14	1.7. Munitions Transportation (Transfer) Cost	8%	15%	23%	14%	16%	13%	25%	38%	24%
15	1.8. Munitions Quality Evaluation/Surveillance Cost									
16	1.8.1. Munitions Quality Evaluation Cost	8%	15%	23%	15%	18%	13%	25%	38%	28%
17	1.8.2. Munitions Surveillance Cost	8%	15%	23%	15%	14%	13%	25%	38%	31%
18	1.9. Inventory (Munitions) Cost	8%	15%	23%	20%	17%	13%	25%	38%	23%
19	1.10. Report Cost	8%	15%	23%	9%	15%	13%	25%	38%	15%
20	1.11. Causative Research Cost	8%	15%	23%	16%	17%	13%	25%	38%	22%
21	2. Demilitarization/Disposal									
22	2.1. Disposal	8%	15%	23%	21%	12%	13%	25%	38%	24%
23	2.2. Labor	8%	15%	23%	14%	17%	13%	25%	38%	20%
24	3. Maintenance and Quality Evaluation Cost									
25	3.1. Scheduled	8%	15%	23%	15%	15%	13%	25%	38%	24%
26	3.2. Unscheduled	8%	15%	23%	20%	19%	13%	25%	38%	37%
27	3.3. Labor	8%	15%	23%	11%	18%	13%	25%	38%	19%
28	3.4. Quality Evaluation	8%	15%	23%	13%	21%	13%	25%	38%	20%
29	4. Hardware Replacement Cost									
30	4.1. Scheduled Hardware Replacement Cost									
31	4.1.1. Scheduled Tags Replacement Cost	-900%	-600%	-300%	-556%	-337%	-1350%	-900%	-450%	-830%
32	4.1.2. Scheduled Frequency Extenders Replacement Cost	-900%	-600%	-300%	-797%	-701%	-1350%	-900%	-450%	-810%

ROI / SAVINGS / INVESTMENTS / Original Cost / ATOS Sav Distr in Not Transf / Cost with ATOS in Not Transf / ATOS Sav Distr in Tran-ed / C

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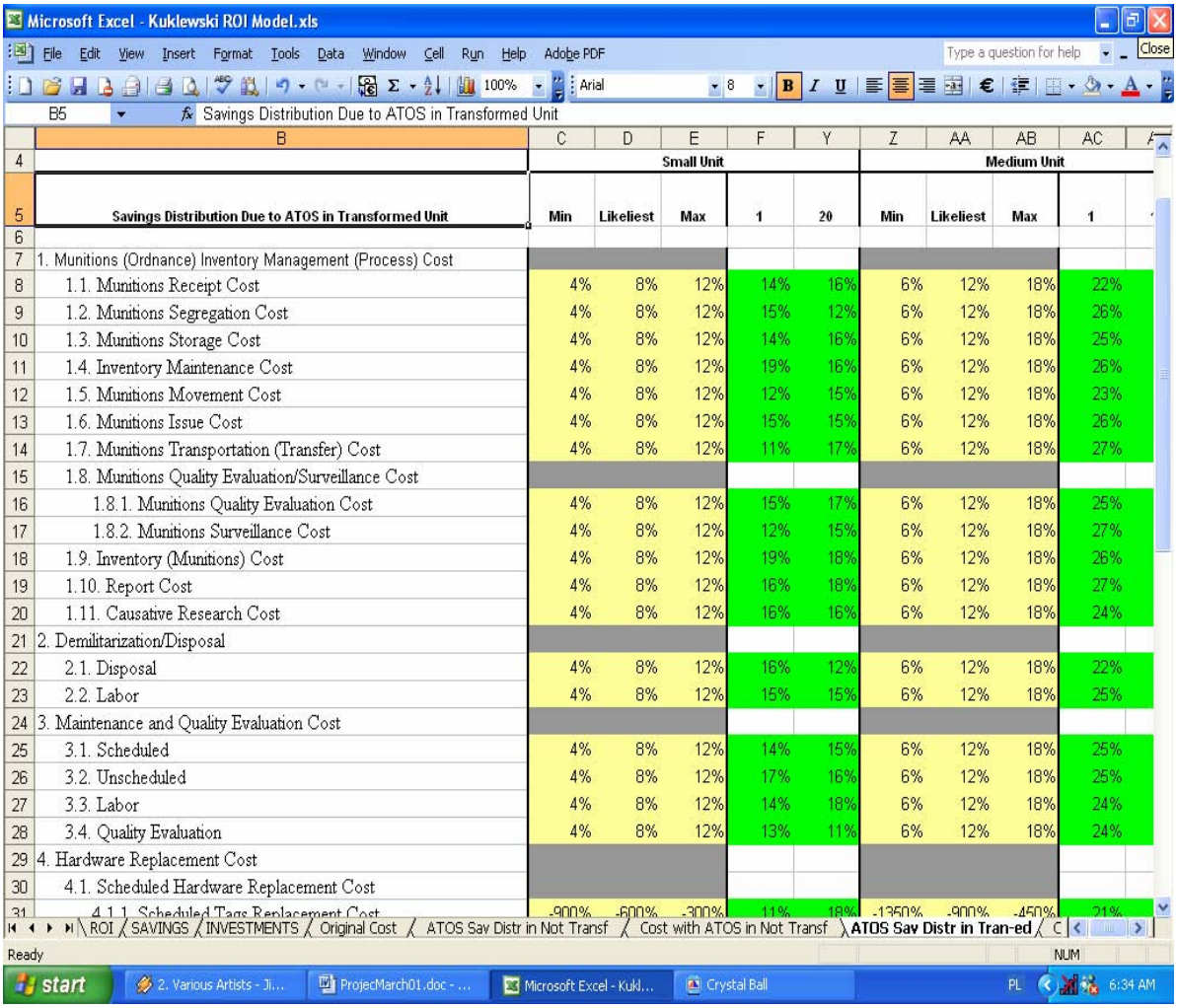
Figure 18. Savings Distribution Due to ATOS in Not Transformed Units Spreadsheet



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B5: Savings Distribution Due to ATOS in Transformed Unit

	B	C	D	E	F	Y	Z	AA	AB	AC
4		Small Unit					Medium Unit			
5	Savings Distribution Due to ATOS in Transformed Unit	Min	Likeliest	Max	1	20	Min	Likeliest	Max	1
6										
7	1. Munitions (Ordnance) Inventory Management (Process) Cost									
8	1.1. Munitions Receipt Cost	4%	8%	12%	14%	16%	6%	12%	18%	22%
9	1.2. Munitions Segregation Cost	4%	8%	12%	15%	12%	6%	12%	18%	26%
10	1.3. Munitions Storage Cost	4%	8%	12%	14%	16%	6%	12%	18%	25%
11	1.4. Inventory Maintenance Cost	4%	8%	12%	19%	16%	6%	12%	18%	26%
12	1.5. Munitions Movement Cost	4%	8%	12%	12%	15%	6%	12%	18%	23%
13	1.6. Munitions Issue Cost	4%	8%	12%	15%	15%	6%	12%	18%	26%
14	1.7. Munitions Transportation (Transfer) Cost	4%	8%	12%	11%	17%	6%	12%	18%	27%
15	1.8. Munitions Quality Evaluation/Surveillance Cost									
16	1.8.1. Munitions Quality Evaluation Cost	4%	8%	12%	15%	17%	6%	12%	18%	25%
17	1.8.2. Munitions Surveillance Cost	4%	8%	12%	12%	15%	6%	12%	18%	27%
18	1.9. Inventory (Munitions) Cost	4%	8%	12%	19%	18%	6%	12%	18%	26%
19	1.10. Report Cost	4%	8%	12%	16%	18%	6%	12%	18%	27%
20	1.11. Causative Research Cost	4%	8%	12%	16%	16%	6%	12%	18%	24%
21	2. Demilitarization/Disposal									
22	2.1. Disposal	4%	8%	12%	16%	12%	6%	12%	18%	22%
23	2.2. Labor	4%	8%	12%	15%	15%	6%	12%	18%	25%
24	3. Maintenance and Quality Evaluation Cost									
25	3.1. Scheduled	4%	8%	12%	14%	15%	6%	12%	18%	25%
26	3.2. Unscheduled	4%	8%	12%	17%	16%	6%	12%	18%	25%
27	3.3. Labor	4%	8%	12%	14%	18%	6%	12%	18%	24%
28	3.4. Quality Evaluation	4%	8%	12%	13%	11%	6%	12%	18%	24%
29	4. Hardware Replacement Cost									
30	4.1. Scheduled Hardware Replacement Cost									
31	4.1.1. Scheduled Tags Replacement Cost	-900%	-600%	-300%	11%	18%	-1350%	-900%	-450%	21%

ROI | SAVINGS | INVESTMENTS | Original Cost | ATOS Sav Distr in Not Transf | Cost with ATOS in Not Transf | ATOS Sav Distr in Tran-ed | C

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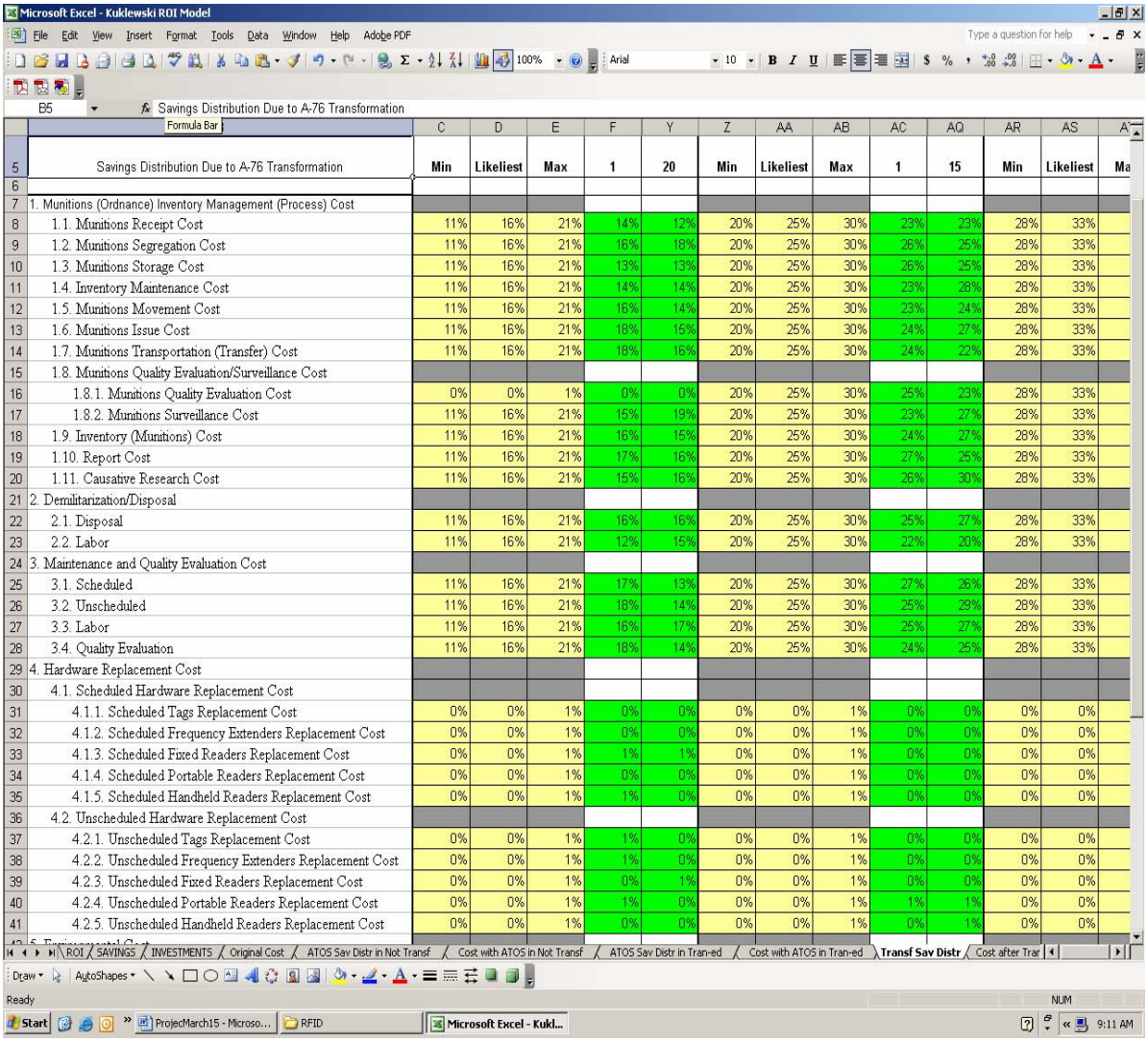
Figure 19. Savings Distribution Due to ATOS in Transformed Units Spreadsheet



Microsoft Excel - Kuklewski ROI Model

B5: Savings Distribution Due to A-76 Transformation

Savings Distribution Due to A-76 Transformation	C	D	E	F	Y	Z	AA	AB	AC	AQ	AR	AS
	Min	Likeliest	Max	1	20	Min	Likeliest	Max	1	15	Min	Likeliest
1. Munitions (Ordnance) Inventory Management (Process) Cost												
1.1. Munitions Receipt Cost	11%	16%	21%	14%	12%	20%	25%	30%	23%	23%	28%	33%
1.2. Munitions Segregation Cost	11%	16%	21%	16%	18%	20%	25%	30%	26%	25%	28%	33%
1.3. Munitions Storage Cost	11%	16%	21%	13%	13%	20%	25%	30%	26%	25%	28%	33%
1.4. Inventory Maintenance Cost	11%	16%	21%	14%	14%	20%	25%	30%	23%	28%	28%	33%
1.5. Munitions Movement Cost	11%	16%	21%	16%	14%	20%	25%	30%	23%	24%	28%	33%
1.6. Munitions Issue Cost	11%	16%	21%	18%	15%	20%	25%	30%	24%	27%	28%	33%
1.7. Munitions Transportation (Transfer) Cost	11%	16%	21%	18%	16%	20%	25%	30%	24%	22%	28%	33%
1.8. Munitions Quality Evaluation/Surveillance Cost												
1.8.1. Munitions Quality Evaluation Cost	0%	0%	1%	0%	0%	20%	25%	30%	25%	23%	28%	33%
1.8.2. Munitions Surveillance Cost	11%	16%	21%	15%	19%	20%	25%	30%	23%	27%	28%	33%
1.9. Inventory (Munitions) Cost	11%	16%	21%	16%	15%	20%	25%	30%	24%	27%	28%	33%
1.10. Report Cost	11%	16%	21%	17%	16%	20%	25%	30%	27%	25%	28%	33%
1.11. Causative Research Cost	11%	16%	21%	15%	16%	20%	25%	30%	26%	30%	28%	33%
2. Demilitarization/Disposal												
2.1. Disposal	11%	16%	21%	16%	16%	20%	25%	30%	25%	27%	28%	33%
2.2. Labor	11%	16%	21%	12%	15%	20%	25%	30%	22%	20%	28%	33%
3. Maintenance and Quality Evaluation Cost												
3.1. Scheduled	11%	16%	21%	17%	13%	20%	25%	30%	27%	26%	28%	33%
3.2. Unscheduled	11%	16%	21%	18%	14%	20%	25%	30%	25%	29%	28%	33%
3.3. Labor	11%	16%	21%	16%	17%	20%	25%	30%	25%	27%	28%	33%
3.4. Quality Evaluation	11%	16%	21%	18%	14%	20%	25%	30%	24%	25%	28%	33%
4. Hardware Replacement Cost												
4.1. Scheduled Hardware Replacement Cost												
4.1.1. Scheduled Tags Replacement Cost	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%
4.1.2. Scheduled Frequency Extenders Replacement Cost	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%
4.1.3. Scheduled Fixed Readers Replacement Cost	0%	0%	1%	1%	1%	0%	0%	1%	0%	0%	0%	0%
4.1.4. Scheduled Portable Readers Replacement Cost	0%	0%	1%	0%	0%	0%	0%	1%	0%	0%	0%	0%
4.1.5. Scheduled Handheld Readers Replacement Cost	0%	0%	1%	1%	0%	0%	0%	1%	0%	0%	0%	0%
4.2. Unscheduled Hardware Replacement Cost												
4.2.1. Unscheduled Tags Replacement Cost	0%	0%	1%	1%	0%	0%	0%	1%	0%	0%	0%	0%
4.2.2. Unscheduled Frequency Extenders Replacement Cost	0%	0%	1%	1%	0%	0%	0%	1%	0%	0%	0%	0%
4.2.3. Unscheduled Fixed Readers Replacement Cost	0%	0%	1%	0%	1%	0%	0%	1%	0%	0%	0%	0%
4.2.4. Unscheduled Portable Readers Replacement Cost	0%	0%	1%	1%	0%	0%	0%	1%	1%	1%	0%	0%
4.2.5. Unscheduled Handheld Readers Replacement Cost	0%	0%	1%	0%	0%	0%	0%	1%	0%	1%	0%	0%

Figure 20. Savings Distribution Due to A-76 Transformation Spreadsheet

The Savings Spreadsheet presented in Figure 21 summarizes the savings for the ATOS and A-76 transformation implementation. In contrast to the previous spreadsheets, this spreadsheet is an outcome of the assumptions and Monte Carlo simulation. There are:

- Savings due to ATOS implementation in not transformed units;
- Savings due to ATOS implementation in transformed units;
- Cumulative savings for the A-76 transformation and ATOS implementation after the transformation.

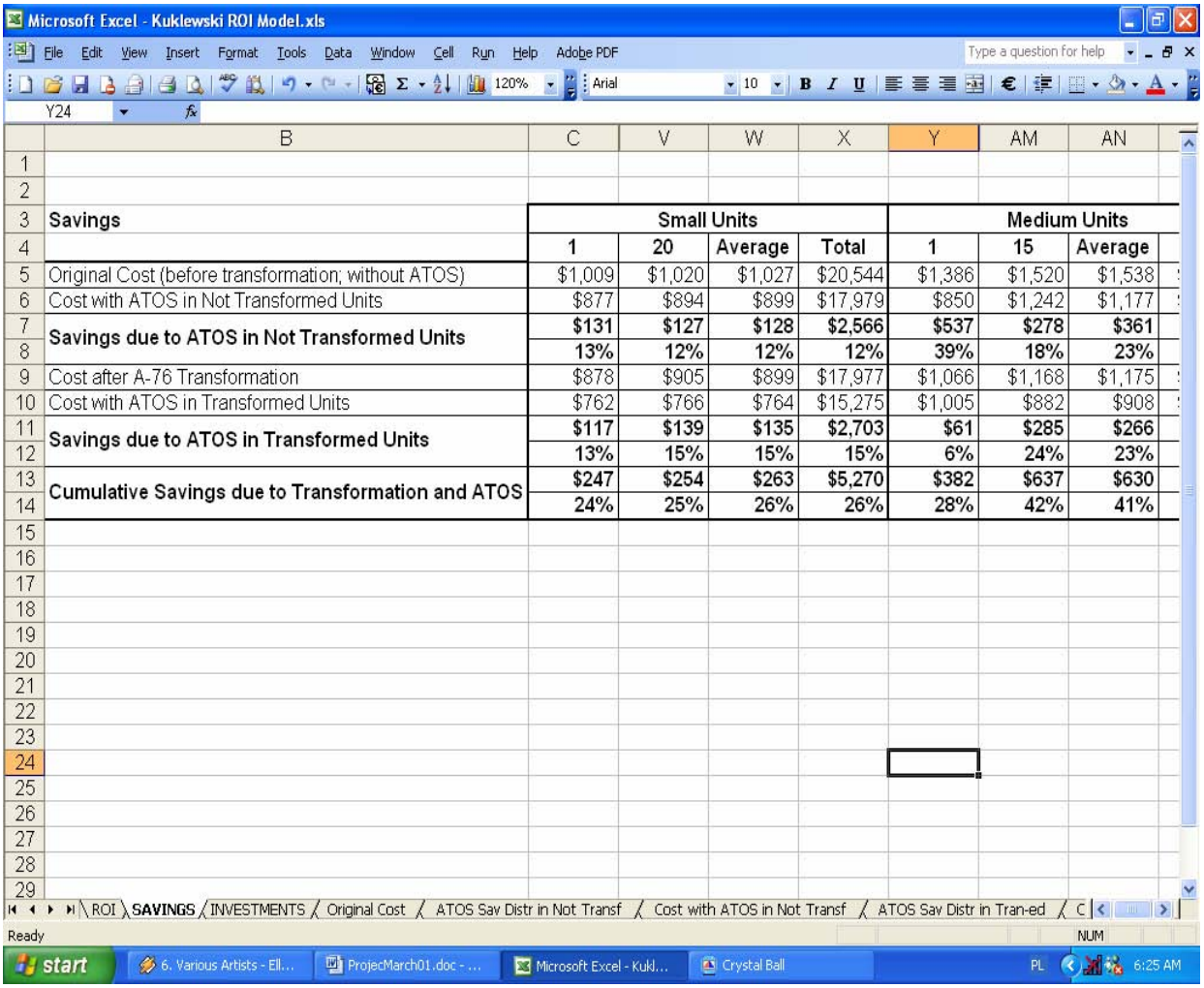
The savings are presented in dollar values as well as a percentage of the original cost. They are presented:

– separately for each munitions management unit;

– as an average value for each size category, and;

– as a total values for each size category and all units together.

These values are further used to compute the ATOS ROI.



	B	C	V	W	X	Y	AM	AN
1								
2								
3	**Savings**	**Small Units**				**Medium Units**		
4		**1**	**20**	**Average**	**Total**	**1**	**15**	**Average**
5	Original Cost (before transformation; without ATOS)	$1,009	$1,020	$1,027	$20,544	$1,386	$1,520	$1,538
6	Cost with ATOS in Not Transformed Units	$877	$894	$899	$17,979	$850	$1,242	$1,177
7	**Savings due to ATOS in Not Transformed Units**	**$131**	**$127**	**$128**	**$2,566**	**$537**	**$278**	**$361**
8		**13%**	**12%**	**12%**	**12%**	**39%**	**18%**	**23%**
9	Cost after A-76 Transformation	$878	$905	$899	$17,977	$1,066	$1,168	$1,175
10	Cost with ATOS in Transformed Units	$762	$766	$764	$15,275	$1,005	$882	$908
11	**Savings due to ATOS in Transformed Units**	**$117**	**$139**	**$135**	**$2,703**	**$61**	**$285**	**$266**
12		**13%**	**15%**	**15%**	**15%**	**6%**	**24%**	**23%**
13	**Cumulative Savings due to Transformation and ATOS**	**$247**	**$254**	**$263**	**$5,270**	**$382**	**$637**	**$630**
14		**24%**	**25%**	**26%**	**26%**	**28%**	**42%**	**41%**
15								
16								
17								
18								
19								
20								
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27								
28								
29								

Figure 21. Savings Spreadsheet

5. To-Be

This part of the model describes the operating and support cost as well as the environmental cost of munitions management units after the ATOS implementation. This,

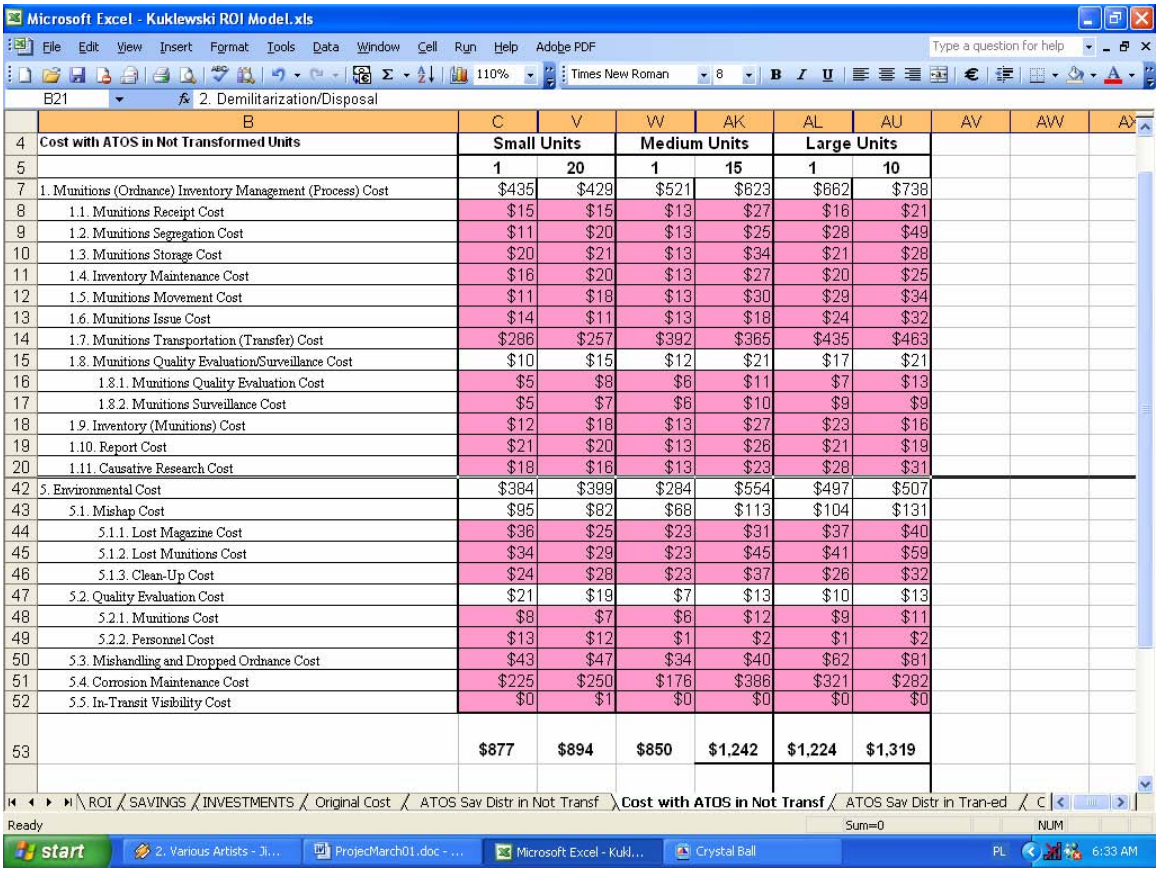
also called *To-Be* cost, is considered separately for transformed and not transformed magazines. The supposition is that the *To-Be* cost is higher for the units that have not undergone the A-76 transformation than for those transformed.

The To-Be cost is represented in two spreadsheets:

– The Cost with ATOS in Not Transf spreadsheet represents the operation and support (O&S) and environmental costs for not transformed units (See Figure 22);

– The Cost with ATOS in Tran-ed spreadsheet for the units which have undergone the A-76 transformation (See Figure 23).

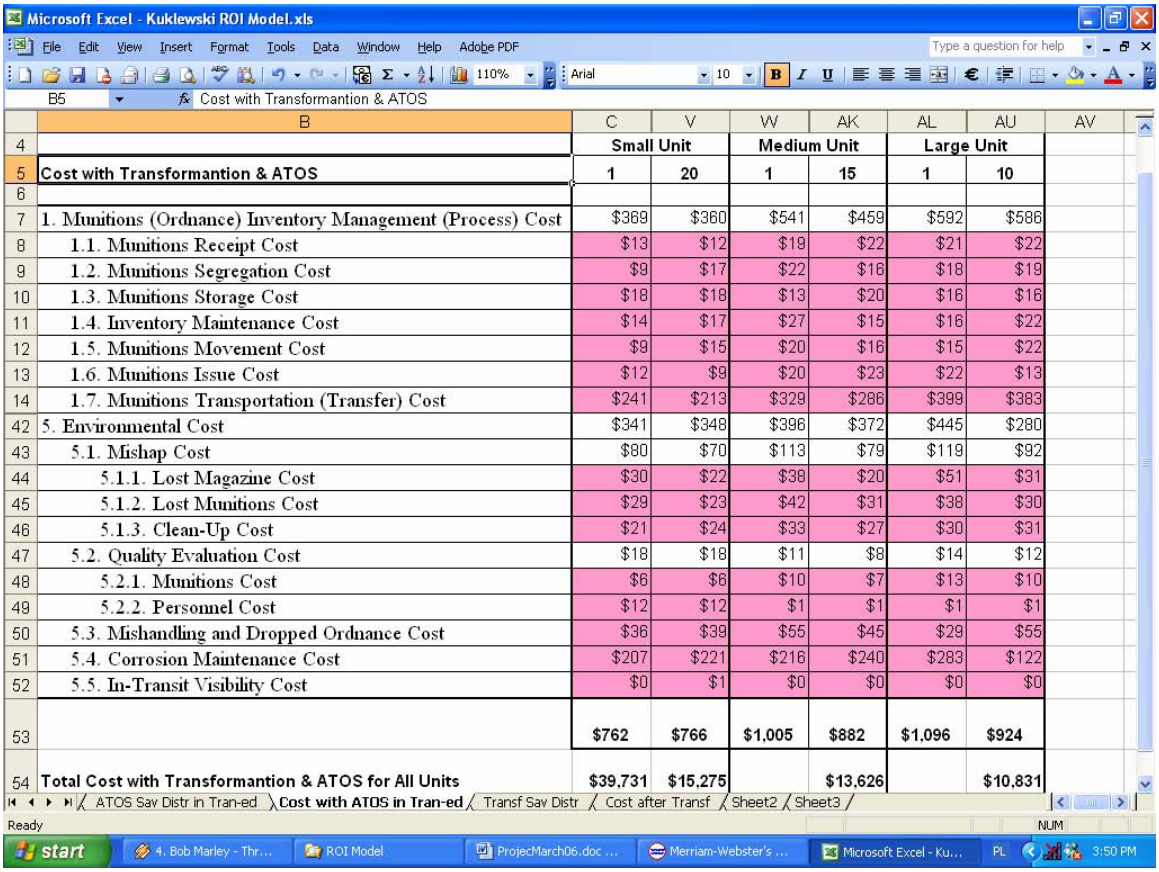
The cost calculated in the *Cost with ATOS in Not Transf* spreadsheet is a result of multiplying the cost from *Original Cost* and the savings possible in not transformed units (*ATOS Sav Distr in Not Transf).*



	B	C	V	W	AK	AL	AU
4	Cost with ATOS in Not Transformed Units	Small Units		Medium Units		Large Units	
5		1	20	1	15	1	10
7	1. Munitions (Ordnance) Inventory Management (Process) Cost	$435	$429	$521	$623	$862	$738
8	1.1. Munitions Receipt Cost	$15	$15	$13	$27	$16	$21
9	1.2. Munitions Segregation Cost	$11	$20	$13	$25	$28	$49
10	1.3. Munitions Storage Cost	$20	$21	$13	$34	$21	$28
11	1.4. Inventory Maintenance Cost	$16	$20	$13	$27	$20	$25
12	1.5. Munitions Movement Cost	$11	$18	$13	$30	$29	$34
13	1.6. Munitions Issue Cost	$14	$11	$13	$18	$24	$32
14	1.7. Munitions Transportation (Transfer) Cost	$286	$257	$392	$365	$435	$463
15	1.8. Munitions Quality Evaluation/Surveillance Cost	$10	$15	$12	$21	$17	$21
16	1.8.1. Munitions Quality Evaluation Cost	$5	$8	$6	$11	$7	$13
17	1.8.2. Munitions Surveillance Cost	$5	$7	$6	$10	$9	$9
18	1.9. Inventory (Munitions) Cost	$12	$18	$13	$27	$23	$16
19	1.10. Report Cost	$21	$20	$13	$26	$21	$19
20	1.11. Causative Research Cost	$18	$16	$13	$23	$28	$31
42	5. Environmental Cost	$384	$399	$284	$554	$497	$507
43	5.1. Mishap Cost	$95	$82	$68	$113	$104	$131
44	5.1.1. Lost Magazine Cost	$36	$25	$23	$31	$37	$40
45	5.1.2. Lost Munitions Cost	$34	$29	$23	$45	$41	$59
46	5.1.3. Clean-Up Cost	$24	$28	$23	$37	$26	$32
47	5.2. Quality Evaluation Cost	$21	$19	$7	$13	$10	$13
48	5.2.1. Munitions Cost	$8	$7	$6	$12	$9	$11
49	5.2.2. Personnel Cost	$13	$12	$1	$2	$1	$2
50	5.3. Mishandling and Dropped Ordnance Cost	$43	$47	$34	$40	$62	$81
51	5.4. Corrosion Maintenance Cost	$225	$250	$176	$386	$321	$282
52	5.5. In-Transit Visibility Cost	$0	$1	$0	$0	$0	$0
53		$877	$894	$850	$1,242	$1,224	$1,319

Figure 22. Cost with ATOS in Not Transformed Units Spreadsheet

The *Cost with ATOS in Tran-ed* spreadsheet contains the costs of O&S, and environmental costs for transformed units. These costs are calculated by multiplying the *Cost after Transf* by the savings probable to achieve in transformed units (*ATOS Sav Distr in Tran-ed*). Figure 23 presents the spreadsheet view.



	B	C	V	W	AK	AL	AU	AV
4		Small Unit		Medium Unit		Large Unit		
5	Cost with Transformantion & ATOS	1	20	1	15	1	10	
6								
7	1. Munitions (Ordnance) Inventory Management (Process) Cost	$369	$360	$541	$459	$592	$586	
8	1.1. Munitions Receipt Cost	$13	$12	$19	$22	$21	$22	
9	1.2. Munitions Segregation Cost	$9	$17	$22	$16	$18	$19	
10	1.3. Munitions Storage Cost	$18	$18	$13	$20	$16	$16	
11	1.4. Inventory Maintenance Cost	$14	$17	$27	$15	$16	$22	
12	1.5. Munitions Movement Cost	$9	$15	$20	$16	$15	$22	
13	1.6. Munitions Issue Cost	$12	$9	$20	$23	$22	$13	
14	1.7. Munitions Transportation (Transfer) Cost	$241	$213	$329	$286	$399	$383	
42	5. Environmental Cost	$341	$348	$396	$372	$445	$280	
43	5.1. Mishap Cost	$80	$70	$113	$79	$119	$92	
44	5.1.1. Lost Magazine Cost	$30	$22	$38	$20	$51	$31	
45	5.1.2. Lost Munitions Cost	$29	$23	$42	$31	$38	$30	
46	5.1.3. Clean-Up Cost	$21	$24	$33	$27	$30	$31	
47	5.2. Quality Evaluation Cost	$18	$18	$11	$8	$14	$12	
48	5.2.1. Munitions Cost	$6	$8	$10	$7	$13	$10	
49	5.2.2. Personnel Cost	$12	$12	$1	$1	$1	$1	
50	5.3. Mishandling and Dropped Ordnance Cost	$36	$39	$55	$45	$29	$55	
51	5.4. Corrosion Maintenance Cost	$207	$221	$216	$240	$283	$122	
52	5.5. In-Transit Visibility Cost	$0	$1	$0	$0	$0	$0	
53		$762	$766	$1,005	$882	$1,096	$924	
54	Total Cost with Transformantion & ATOS for All Units	$39,731	$15,275		$13,626		$10,831	

Figure 23. Cost with ATOS in Transformed Units Spreadsheet

C. INPUT DATA AND OUTCOMES

Since no data are available, all the numbers used in the Excel model, concerning costs and probable savings, are just the best guess estimates or model numbers.

V. OBSERVATIONS, CONCLUSIONS AND RECOMMENDATIONS

As a result of the work done in this project, the following observations and conclusions are identified.

- The return on investment model, concerning the implementation of ATOS in munitions management enterprise was developed. The model incorporates uncertainty related to the savings to be achieved as well to the original, baseline costs;
- Transformation in the sense of business process reengineering, as described in the FAIR Act and OMB Circular A-76, is very important in making munitions management installations more effective and efficient;
- Based on notional data and trade offs, it can be concluded that it is very important to do the A-76 transformation before the ATOS implementation;
- Conclusions from the Turbo CADS exercise lead to the Gen2 RFID technology. This technology provide better in transit visibility for less upfront investment and lower operating cost;

In addition to the observations and conclusions alone, the next steps for future work are identified.

There is a need for a full BCA on ATOS, and this would be accomplished under a Pilot Project. NPS should support this effort in the following areas:

- Collection of data for baseline, As-Is, conditions;
- Collection for data for changes that occur when ATOS is implemented and that support the To-Be analysis;
- Executing the model built using the above data.

NPS should support analyses that compare the capabilities of first and second generation RFID technologies.

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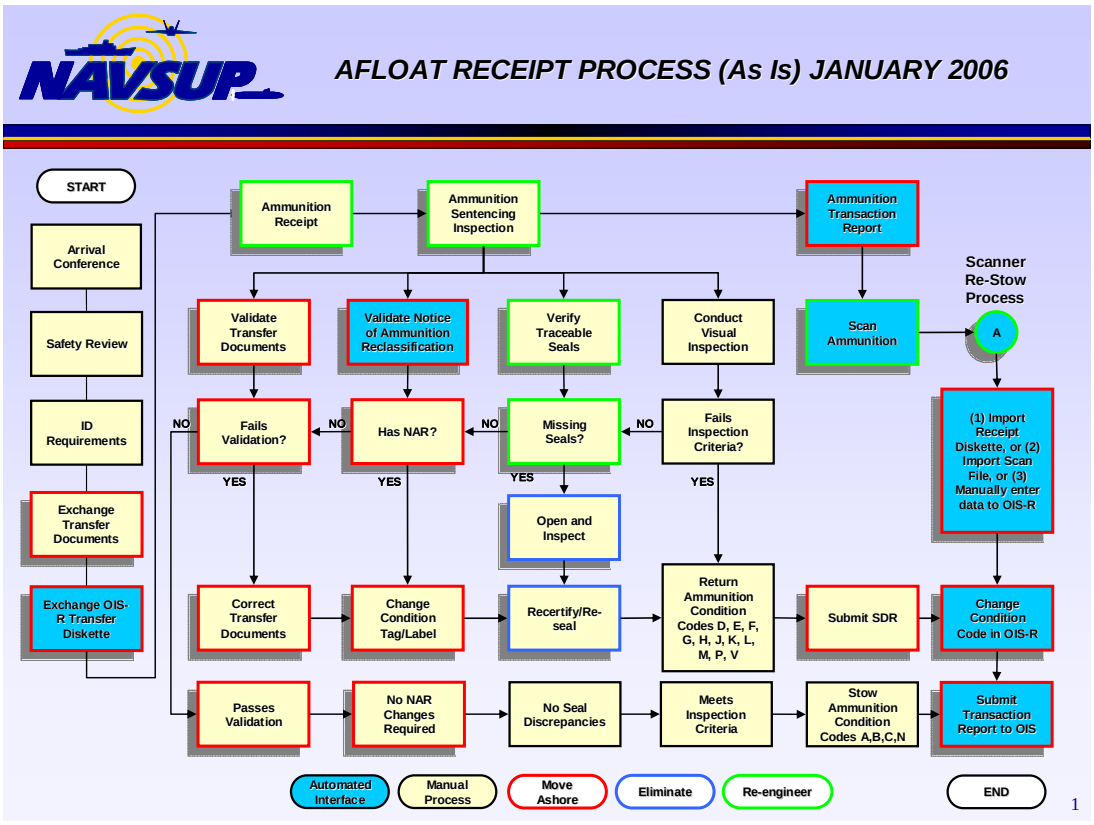
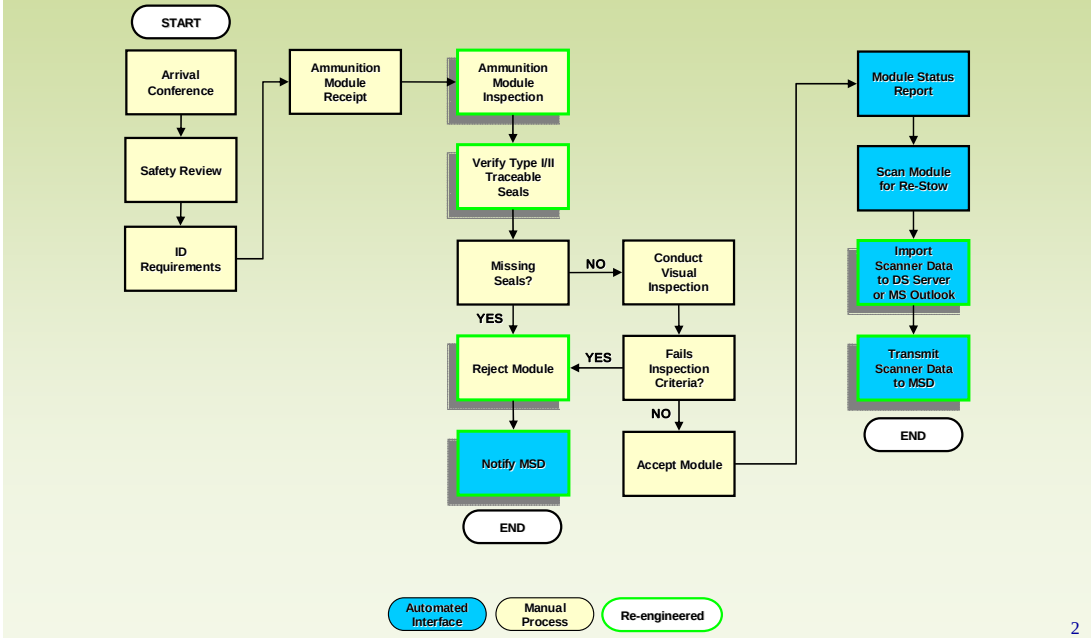
APPENDIX A. MUNITIONS MANAGEMENT PROCESSES

The following charts show the current and targeted munitions management activities. They include afloat and ashore functions. These charts come from Mr. Mentikov's presentation given on January 28, 2006, at NWS Seal Beach.



LCS MODULE RECEIPT PROCESS (To Be) JANUARY 2006



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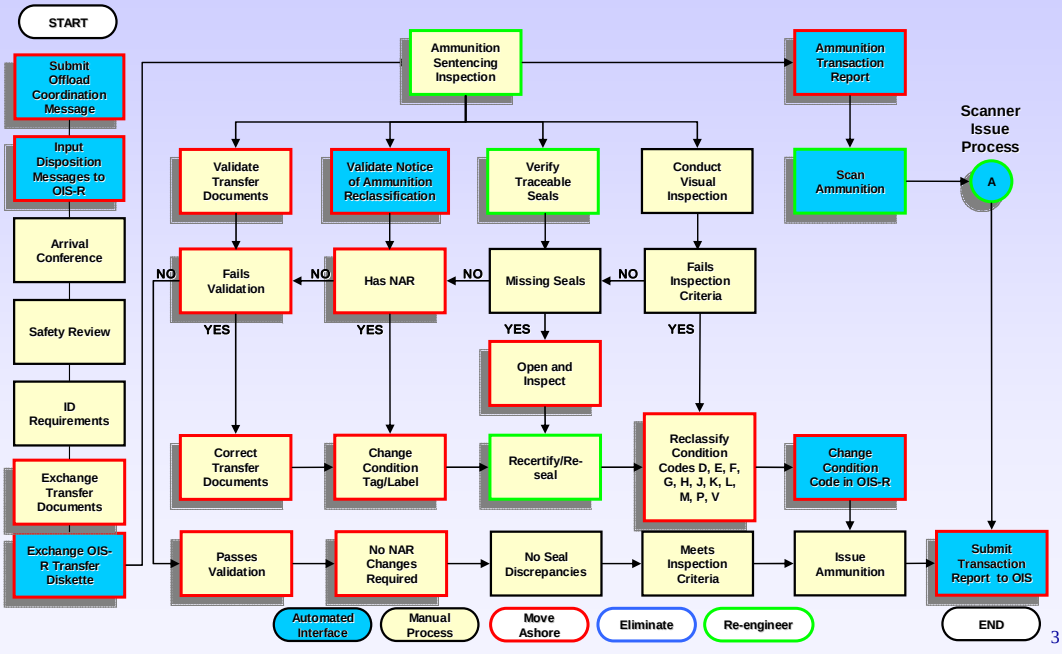
AFLOAT ISSUE PROCESS (As Is) JANUARY 2006



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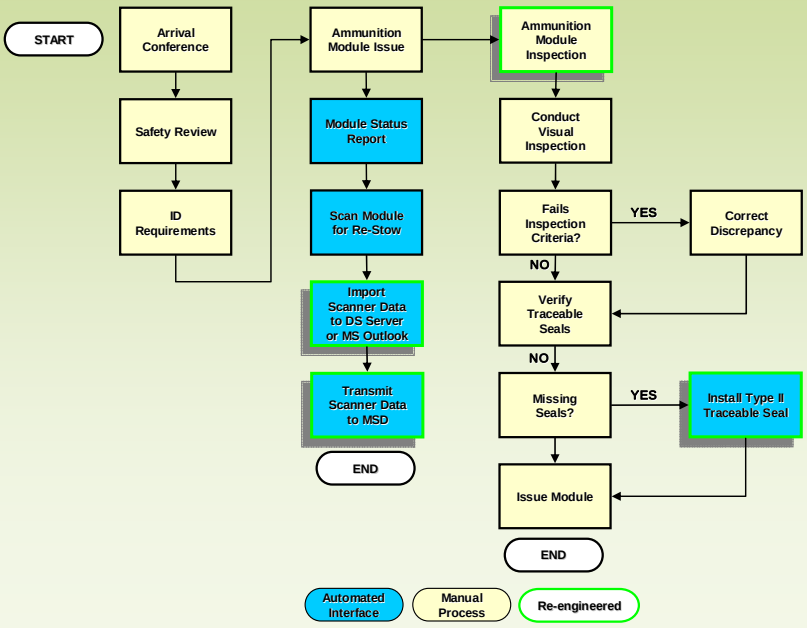

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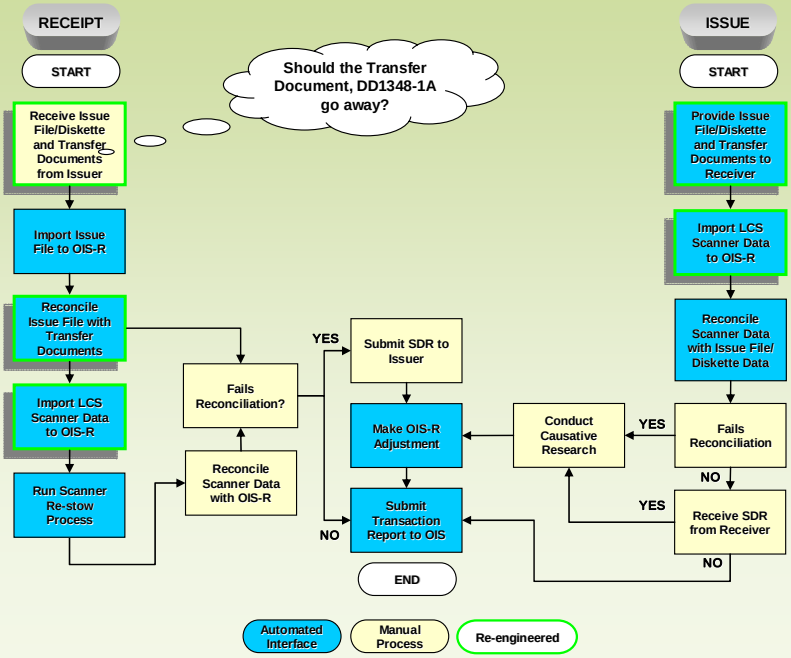
MSD REPORTING PROCESS (To Be) JANUARY 2006



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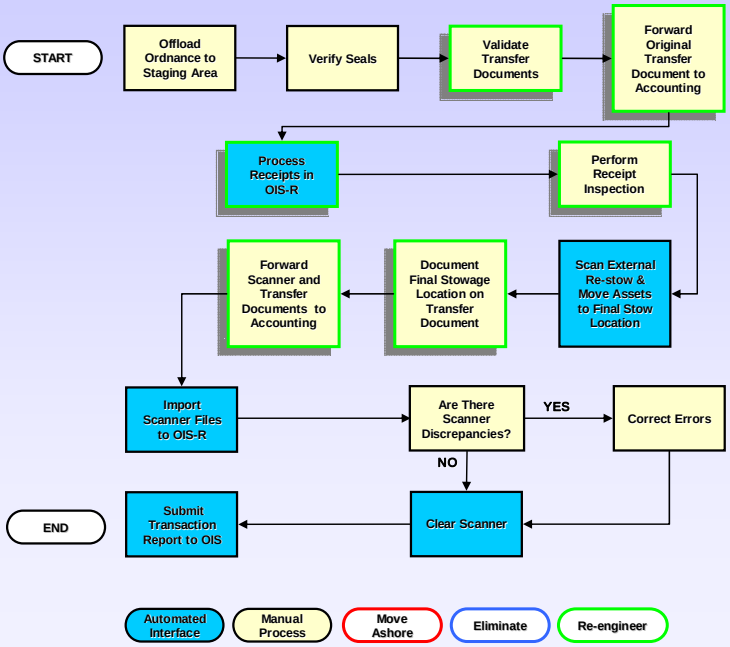
ASHORE RECEIPT PROCESS (As Is) JANUARY 2006



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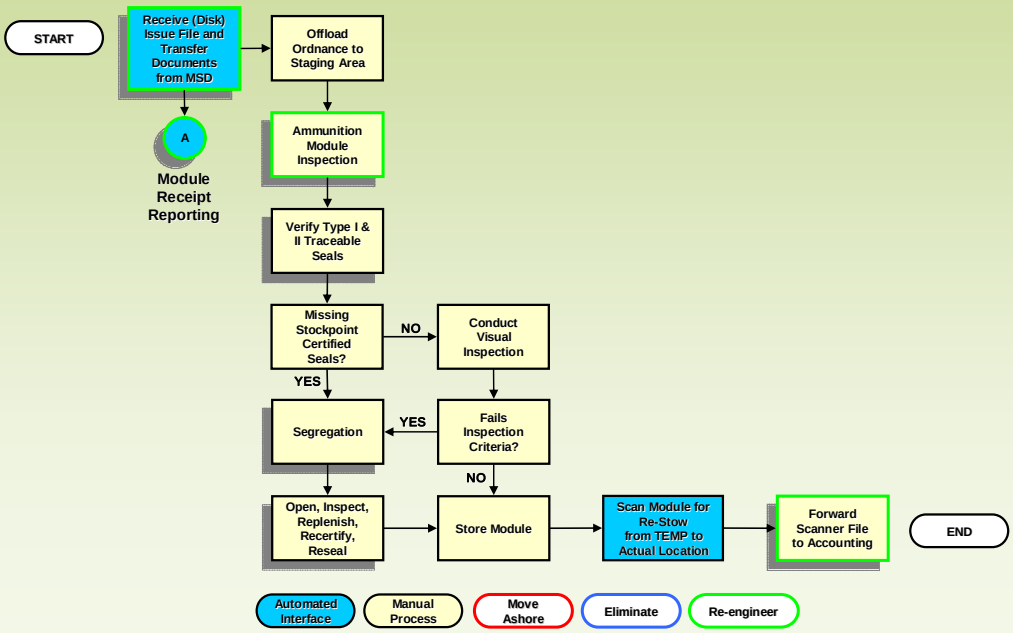

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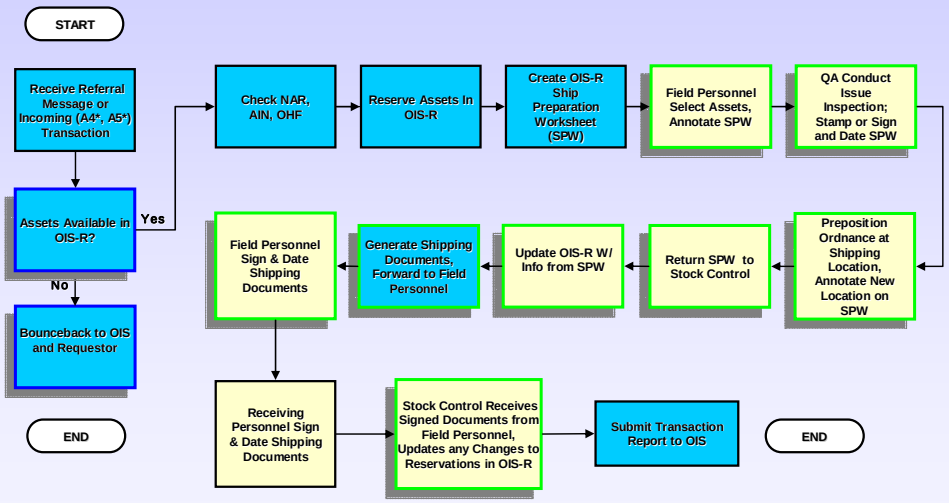
ASHORE ISSUE PROCESS (As Is) JANUARY 2006



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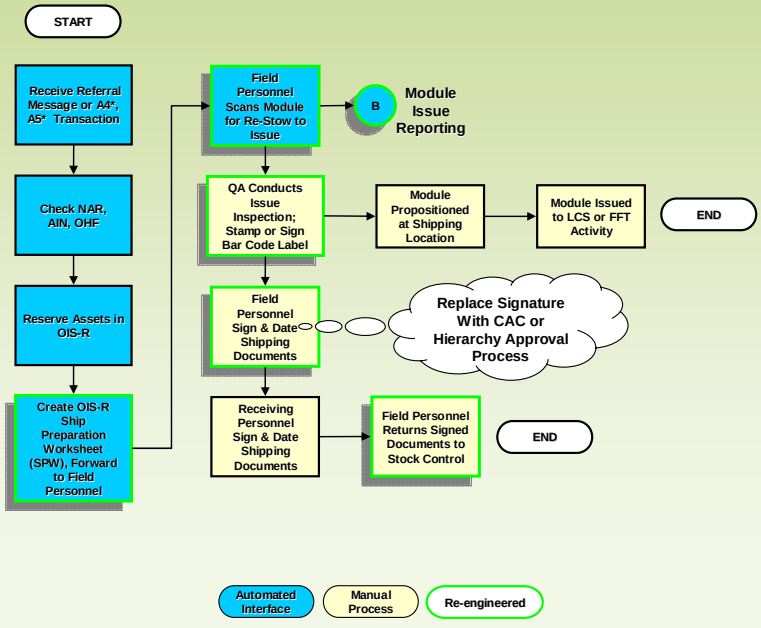

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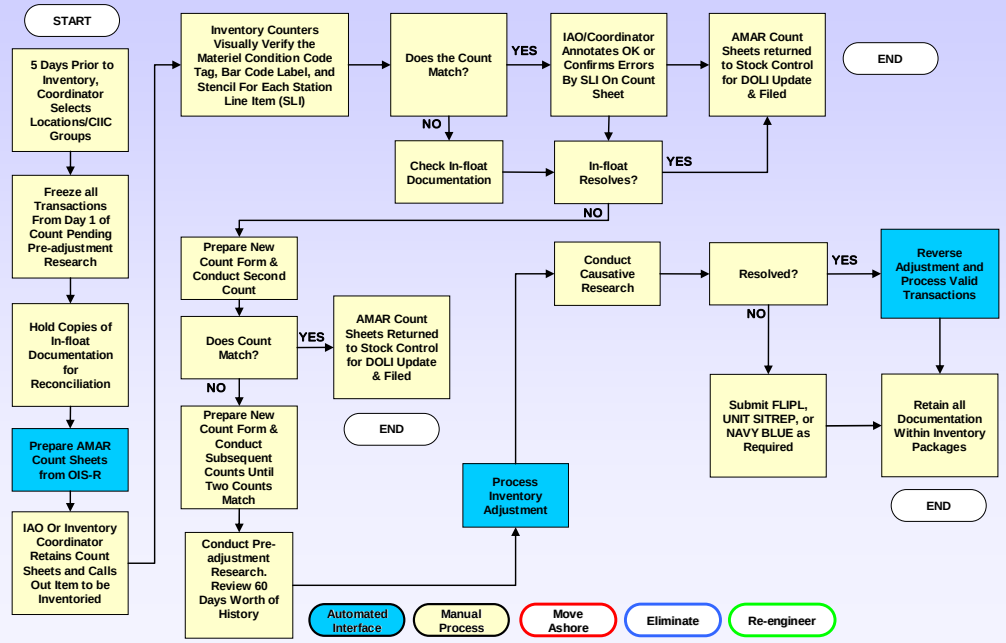
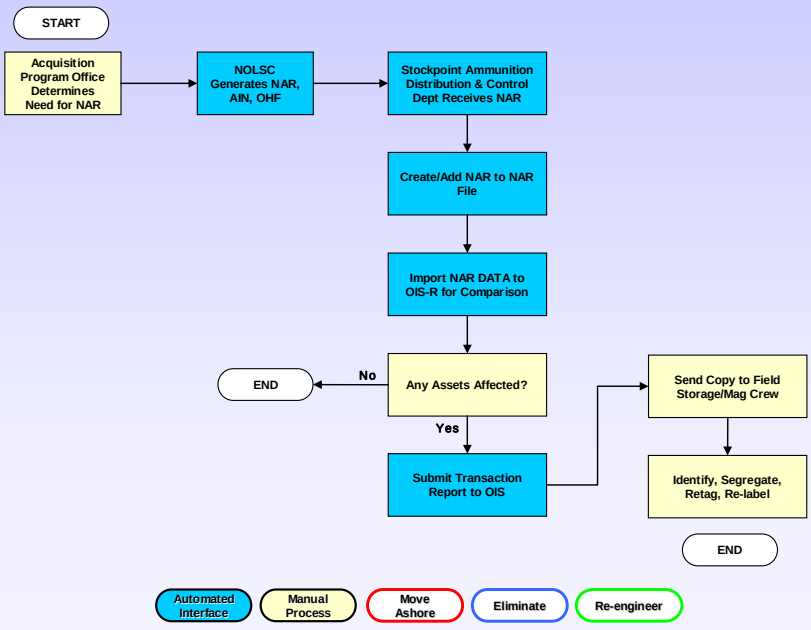
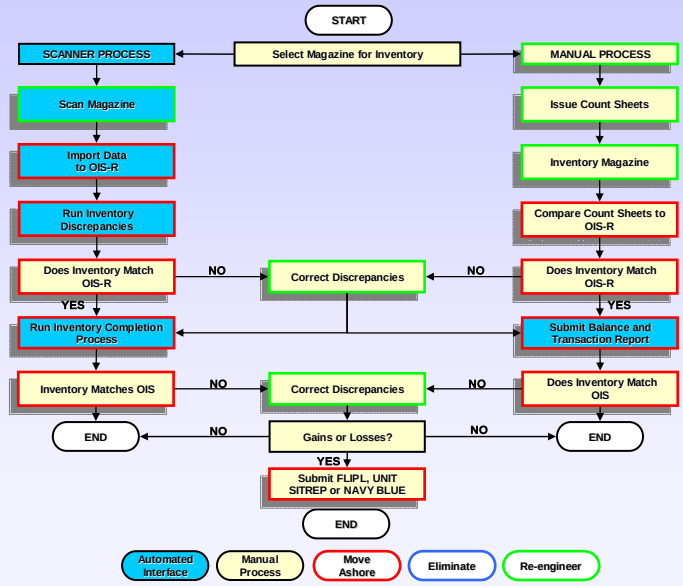


ASHORE NAR PROCESS (As Is) JANUARY 2006



AFLOAT INVENTORY PROCESS (As Is) JANUARY 2006



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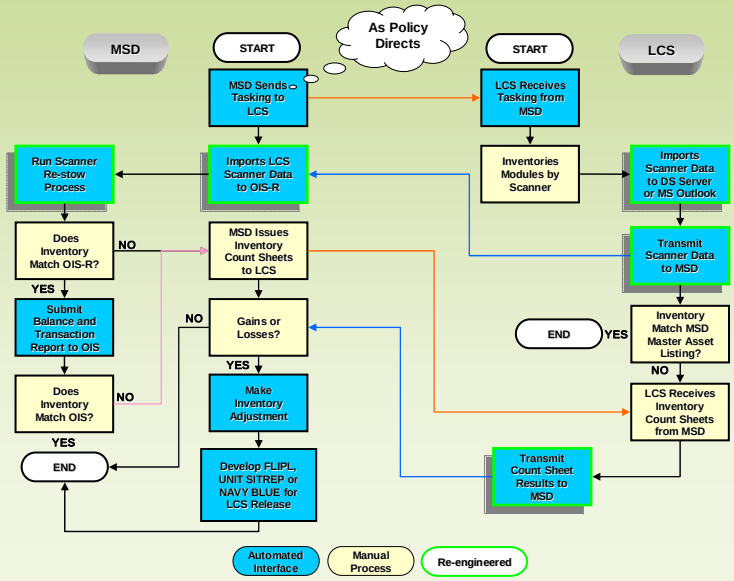
MSD - LCS INVENTORY PROCESS (To Be) JANUARY 2006



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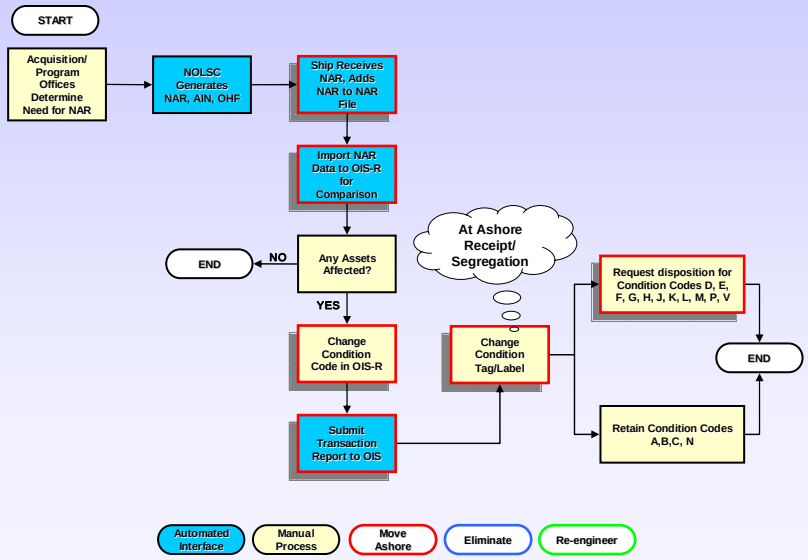
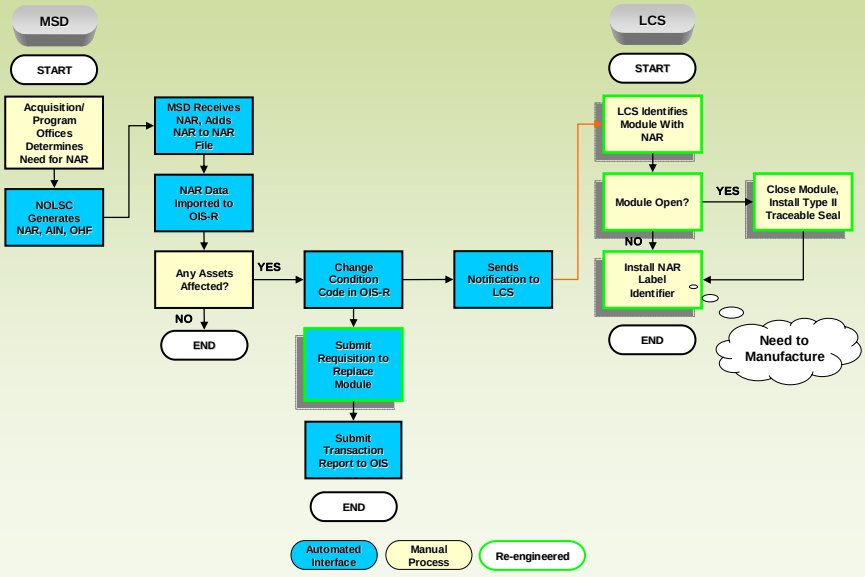
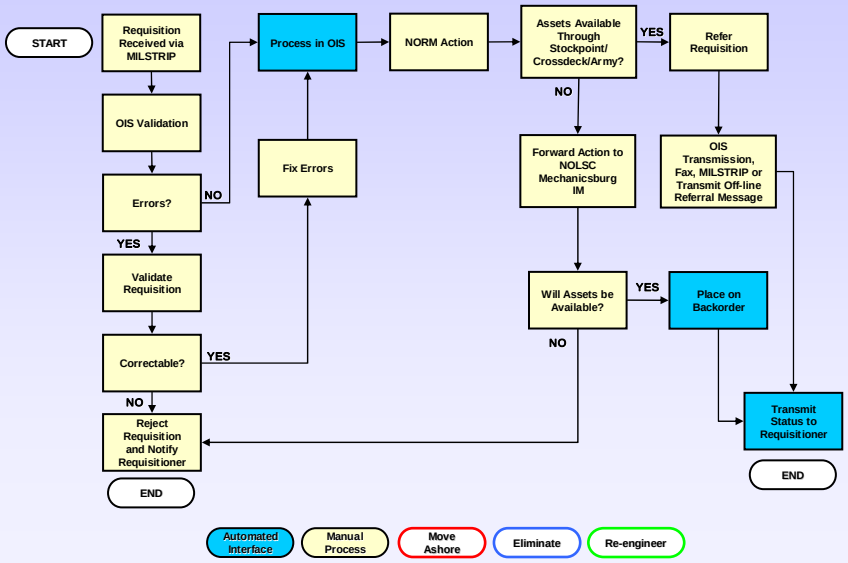


MSD - LCS NAR PROCESS (To Be) JANUARY 2006



ASHORE REQUISITIONING (As Is) JANUARY 2006



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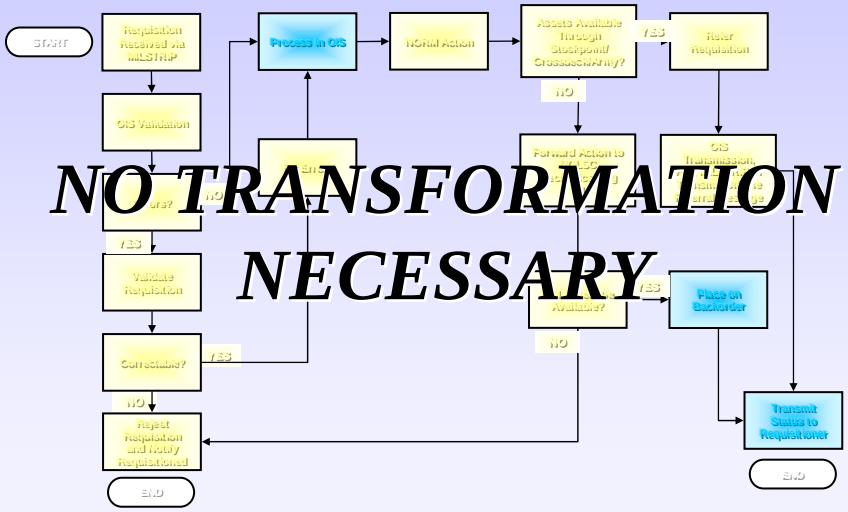
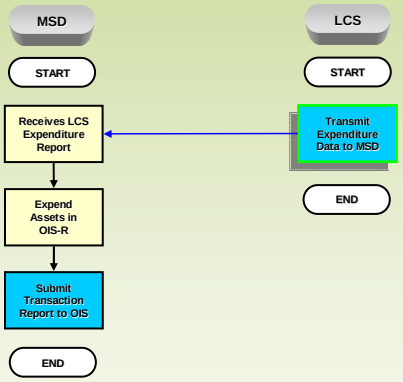
ASHORE REQUISITIONING (As Is) JANUARY 2006



NO TRANSFORMATION NECESSARY

19

MSD - LCS EXPENDITURE PROCESS (To Be)
JANUARY 2006



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AFLOAT SCANNER RESTOW PROCESS (As Is)
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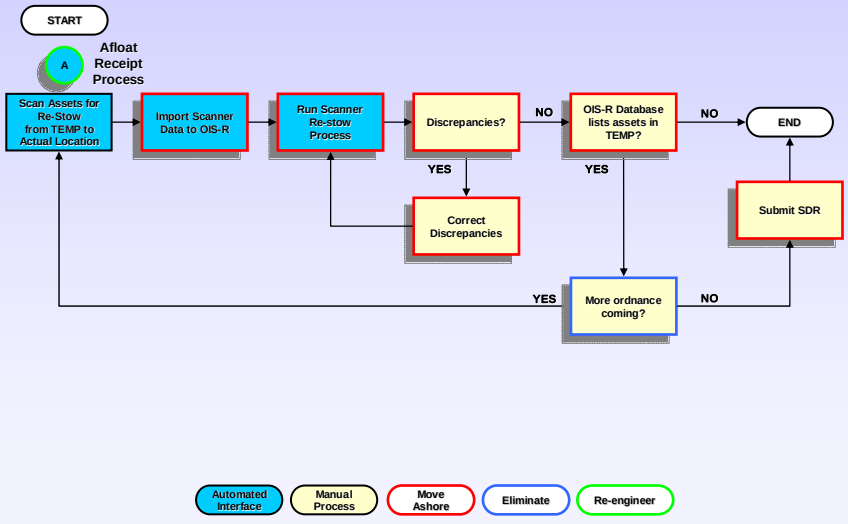

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AFLOAT SCANNER ISSUE PROCESS (As Is)
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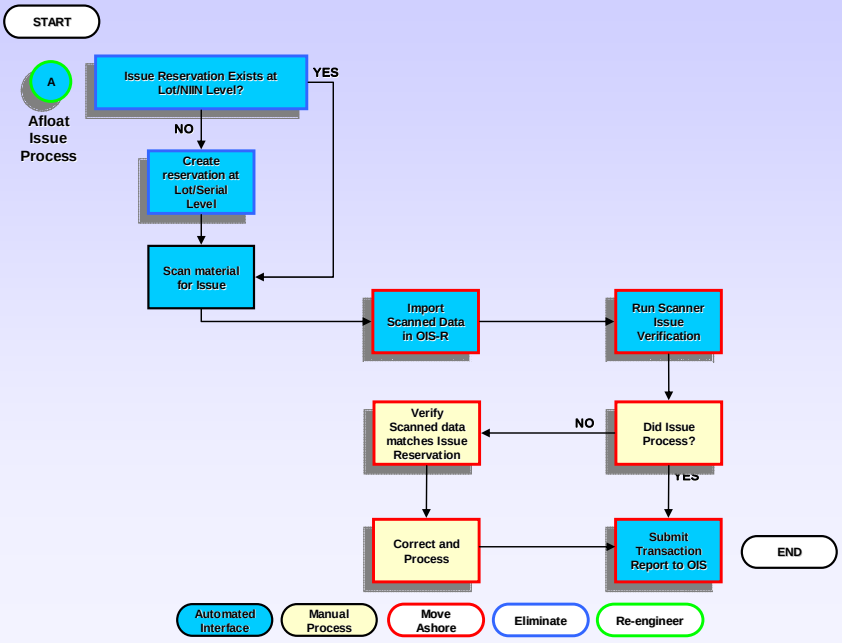
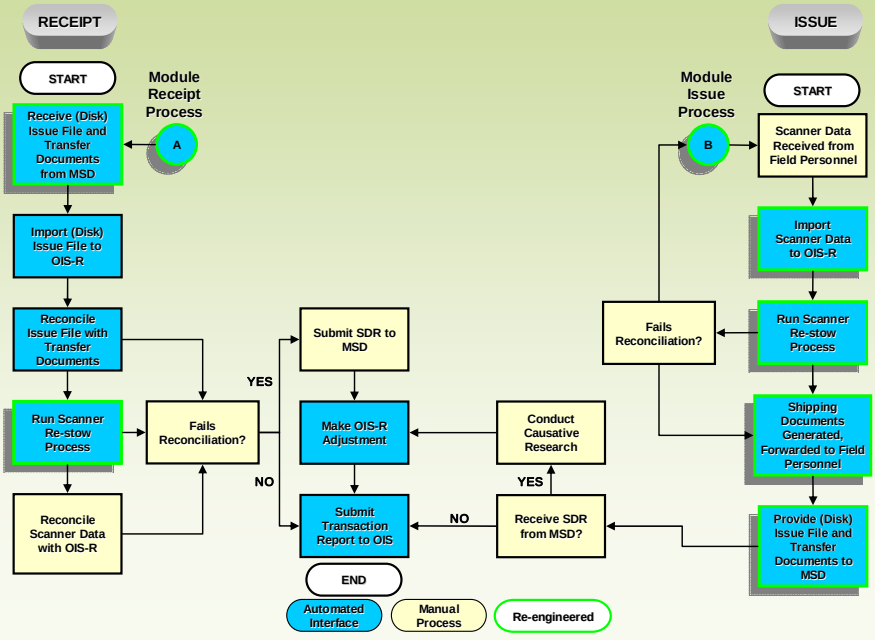


22

ASHORE MODULE REPORTING PROCESS (To Be)
JANUARY 2006



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APPENDIX B. ADVANCED TECHNOLOGY ORDNANCE SURVEILLANCE ADVANCED CONCEPT TECHNOLOGY DEMONSTRATION FY 2006 COST BENEFIT ANALYSIS PILOT PLAN

Background

The Advanced Technology Ordnance Surveillance (ATOS) project is an Office of the Secretary of Defense (OSD) Advanced Concept Technology Demonstration (ACTD) initiative sponsored by the United States European Command (EUCOM) and led by the Department of Navy with joint support from the U.S. Army Materiel Command (AMC), U.S. Army Field Support Command and Joint Munitions Command (AFSC/JMC), U.S. Marine Forces, Atlantic (MARFORLANT), and U.S. Navy Commander Atlantic Fleet (CINCLANTFLT).

ATOS asset data allows logisticians and munitions managers to monitor selected munitions either in transit or from their storage environments to the warfighter using existing Department of Defense databases. ATOS also facilitates automated inventory management within an asset or commodity management system to include receipt, segregation, storage, and issue functions.

ATOS technology is certified to meet Hazards of Electromagnetic Radiation to Ordnance (HERO) zero standoff specifications allowing for the ATOS Radio Frequency Identification (RFID) tags to be placed directly on the ordnance it is monitoring. ATOS is designed to monitor and collect temperature, humidity, and shock data and events and compile a historical profile via automatic, wireless transmission to a data warehouse at programmed predetermined intervals. This provides ordnance technicians insight into whether the selected munitions are exposed to conditions that adversely impact their reliability.

During its development and demonstration with ordnance, it became apparent that the ATOS concept is applicable to any commodity subject to shelf-life issues. The ATOS product design introduces a vanguard capability that provides a view into the third dimension of asset visibility (i.e., 1. identity, 2. location, and *3. condition*), which completes all essential asset visibility information.

Objective

As an ACTD, ATOS has been successfully demonstrated under a MUA – with the final report being issued in November of 2004. The ATOS stated goal is to field a system that gives ordnance managers the ability to accurately locate and continuously determine the status of individual munitions, on a near real-time, automated basis while simultaneously updating predictions of their future condition and performance, with a high level of

confidence. Therefore, the scope of this pilot is to assess the value (or return on investment) of ATOS to ordnance management functions. The primary purpose of this pilot is to perform an independent CBA on two key aspects of ATOS – its impact on ordnance inventory management (IM) and on environmental surveillance/data collection processes.

Goals of this pilot include:

- The inventory demonstration will capture and quantify the capability of the active RFID tags, in conjunction with appropriate support hardware and software, to improve inventory management processes.
- ATOS will be integrated or interfaced with the respective information management system (Ordnance Information System (OIS) for the Navy) in order to provide automated environmental condition monitoring that facilitates improved, automated Quality Evaluation (QE) and life cycle management functions.

Participants will include NPS, NSWCIHD, ordnance handlers (at selected sites for Phase II), inventory managers and ammunition inventory database owners. All identified tasks for each phase require the full cooperation from all participants. Sites in the implementation pilot include Yorktown (Navy site), Seal Beach (Navy site), and Naval Air Station Sigonella (NASSIG) (EUCOM site). Proposed assets include Standard Missile, HELLFIRE, and HARM.

CBA Plan

The CBA will be performed in two phases. The first phase focuses on the development of a framework for determining the Phase II Return On Investment (ROI). The second phase includes an installation of the ATOS system at selected sites associated with the management of the selected missiles and an analysis of current or as-is and to-be processes at those sites.

Assumptions:

Analytical assumptions provide additional scope/shape to the CBA, while the technical assumptions offer more of a "how-to" for conducting the CBA.

Analytical assumptions include:

- Costs for Unique Identifier (UID) and Serialized Item Management (SIM) are not associated with the cost of implementing ATOS
- Documentation of as-is and to-be processes will be reviewed and approved by each site Receipt, Segregation, Storage & Issue (RSSI) manager.

- Business process analysis will be performed by NPS.
- Even though the scope of this pilot is limited, it will accurately reflect either in notional or surrogate manner the complete effect of ATOS within a given application.
- Primary focus of pilot is on inventory management; secondary focus is environmental condition monitoring capabilities. OIS integration will be accomplished with OIS providing links back to any Environmental Databases (EDBs) if needed.

Technical assumptions include:

- There will be no mechanical fixations or modifications to the magazine required.
- Fixed readers will be placed in both the Yorktown and Seal Beach site magazines.
- One or two handheld readers per site.
- Total of 250 tags, 4 handheld readers, up to 5 fixed reader systems and additional support equipment as needed
- Each site will provide personnel for site survey, installation, and training at no cost to pilot.

CBA Plan Tasks

Phase I: Development of a Framework for the calculation of an Ordnance Management ROI. – COMPLETED 12/16/2005
The tasks for Phase I included developing a framework to use in performing the return on investment analysis. This analysis occurred between August and December. A report on Phase I findings has been distributed.

Phase II: As-Is and To-Be Analysis of Inventory Management
The tasks for Phase II include identifying IM business processes affected by the implementation of RFID with sensors, collecting data specific to IM processes, acquiring additional hardware, integrating ATOS into participating service Ammunition Inventory System (AIS), performing site surveys, installation of hardware, training of ordnance handlers at selected service sites, execution of pilot, analyzing data, and reporting/publishing the final report conclusions. Note: Use case scenarios will be determined by the RSSI manager of each site working with the ATOS project team.

1. Site Surveys of all selected sites – Each individual site involved in the demonstration will require a site survey. These site surveys provide information needed to determine the equipment requirements such as: location of magazine, size of magazine, structure of magazine (i.e.

placement of support columns, materials used in magazine) power/communication infrastructure, and potential interference issues.

During the site surveys, site participants will work with NPS and provide information pertinent to the 'AS-IS' business process at their site. RSSI site managers will work with NPS and NSWCIHD personnel to document the 'TO-BE' processes and test scenarios for their site. (See Appendix B for overview of ATOS applications to ordnance business processes.) This knowledge allows for the installation of the optimal RFID system for a specific site as determined by their ordnance management business processes and an accurate ROI to be calculated following the pilot.

A report for each site will be provided one week after the site survey is performed. This report will be reviewed and approved by RSSI managers, NPS, NSWCIHD, and OPNAVN411.

Note: Based on the site survey results, hardware will be procured if needed from the original ATOS prototype vendors. HERO approvals will be verified and provided to site personnel. Equipment will be delivered to sites following system checkout at NSWCIHD.

2. Training of site personnel. Each site will identify the personnel (who and quantity) to be trained in the operation of the ATOS system. Following the site survey and discussions with site personnel of their current business processes and test scenarios, training course will be updated if needed.

3. Installation of tags on missile assets. Site personnel will perform the tagging operations using the handheld readers provided from results of task 1. Items to be tagged will be determined prior to tagging operation by the participating service and site personnel.

4. Installation of magazine equipment at sites. NSWCIHD, site personnel, and service AIS personnel will install required equipment at identified sites. See Appendix A. System checkouts will be performed following installation. Proposed magazine installation dates will be worked with site personnel and service AIS personnel following task 1.

5. Collection of data for To-Be Analysis. IM data will be collected and provided to NPS personnel by site and service AIS personnel. Environmental data will be collected from tagged assets and provided to asset QE personnel. The findings of the QE personnel will be incorporated into NPS's final report.

6. Report on implementation pilot findings. NPS will provide the final report to OSD following analysis of collected data from each site. Report will also be released to all participants.

Total Phase II schedule: ~6 months

Documents

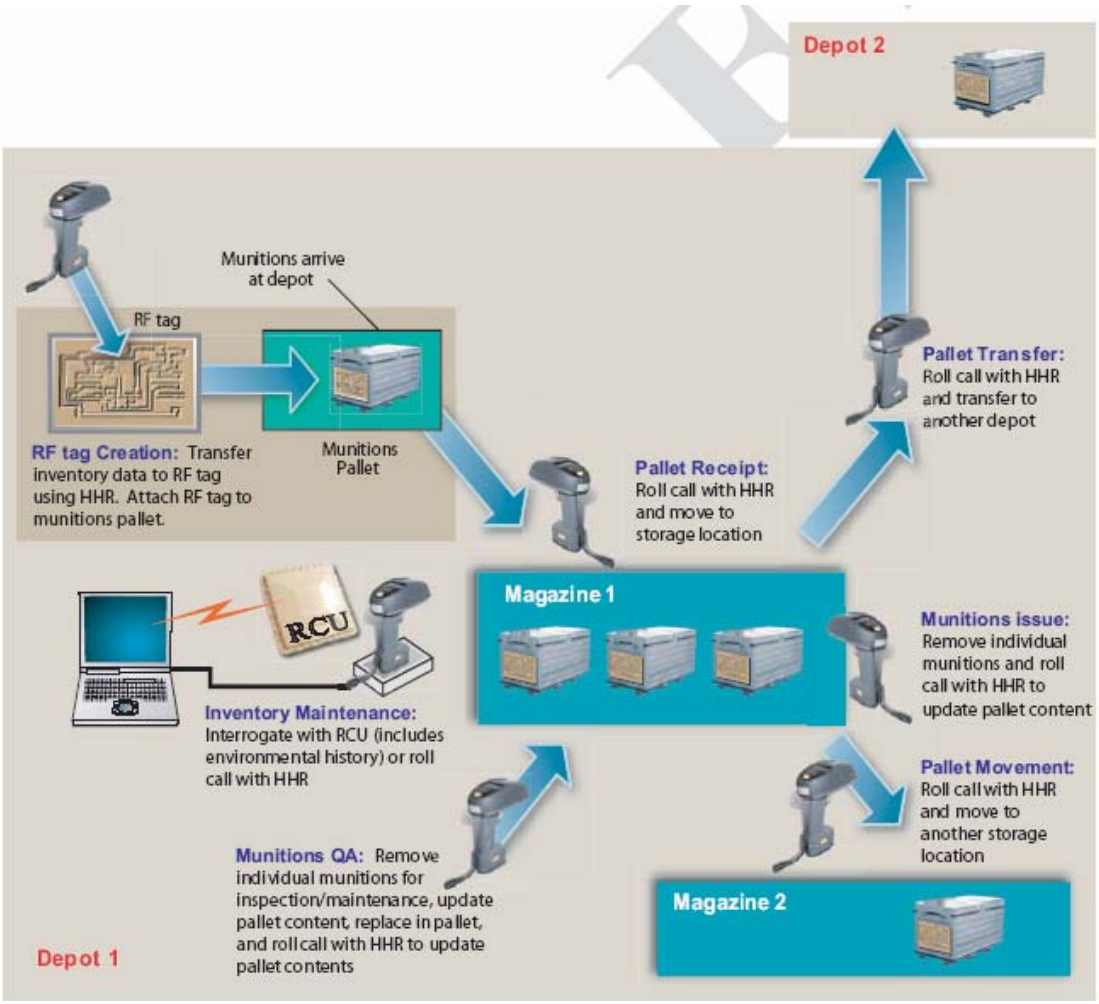
- Site Survey results from each participating site
- Results from Phase I.
- Final Report on Benefits of using ATOS RFID with sensors for Inventory Management Processes and Environmental Monitoring and Surveillance

Appendix A: Equipment needed per Site

	Magazines			Hardware		
Site	Standard Missile	Hellfire	HARM	Tags	Fixed Reader	HHR
Yorktown	1	1	0	100	2	1
Seal Beach	2	1	0	100	2 (maybe 3)	2
NASSIG	0	0	1	50	0	1
Totals	3	2	1	250	4	4

Appendix B: ATOS's Application to Ordnance Management Business Processes

Note: Although pallets are indicated below, this process can also be applied to containers.


Depot 2
Munitions arrive at depot
RF tag
Munitions Pallet
RF tag Creation: Transfer inventory data to RF tag using HHR. Attach RF tag to munitions pallet.
Pallet Transfer: Roll call with HHR and transfer to another depot
Pallet Receipt: Roll call with HHR and move to storage location
Magazine 1
RCU
Inventory Maintenance: Interrogate with RCU (includes environmental history) or roll call with HHR
Munitions issue: Remove individual munitions and roll call with HHR to update pallet content
Pallet Movement: Roll call with HHR and move to another storage location
Munitions QA: Remove individual munitions for inspection/maintenance, update pallet content, replace in pallet, and roll call with HHR to update pallet contents
Magazine 2
Depot 1

Munitions Management Processes using ATOS	
Name	**Process**
Pallet Receipt	When munitions arrive at a depot, munitions or logistics personnel attach RF tags to munitions pallets and populate RF tags with asset information for each munitions pallet using the HHR. Next, tagged munitions pallets are receipted and the asset information is stored on the HHR as a transaction record. Tagged munitions pallets are moved to a storage location where the RCU retrieves the asset information and the latest environmental data from the munitions pallets. The RCU updates and stores the RF tag data until the PP commands it to transfer the data via WLAN, LAN, or the HHR serial port. The PP reconciles the transaction records from the HHR and RCU data, updates the inventory list, and graphically displays the data on the computer screen.
Inventory Maintenance	The RCU maintains the munitions inventory through periodic interrogations of the RF tags. If the RCU encounters a new or missing RF tag, it sends a flag to the PP. When conducting inventory tasks using an HHR, the ATOS operator first downloads the inventory list from the PP to the HHR. The operator then takes the HHR to the magazine. The HHR queries the RF tags and reconciles the inventory list with the tagged munitions pallets inside the magazine. Any new or missing RF tags are flagged by the HHR and associated data are later transferred to the PP. The operator takes appropriate actions to resolve any flags that were sent to the PP from the HHR or RCU. Throughout this process, the RF tags continually collect and store environmental data.
Pallet Movement	Tagged munitions pallets are moved from one location to another within the same depot. The operator uses the HHR to update the RF tag location information. On the next interrogation, the RCU automatically updates location data on the PP inventory list.
Pallet Issue	The operator issues one or more individual munitions items from tagged munitions pallets to a local field unit and uses the HHR to update the munitions count on the RF tag. The RCU captures the munitions count change and updates the PP inventory list.
Pallet Transfer	The operator ships a tagged munitions pallet to a location outside of the depot, using the HHR to document the transfer. The operator uses the HHR to download the latest asset information, environmental data, and any alarm flags. The HHR is docked to the PP and data are transferred to the PP. The RF tag ID number is removed from the inventory list and the data are archived. The PP automatically updates the inventory records of the losing depot when the HHR is docked to the PP. Munitions pallets are not tracked while in transit between depots, but the RF tags will continue to collect environmental data, which is transferred to the PP at the final destination.
Munitions QA	The operator removes one or more individual munitions items from tagged munitions pallets for inspection/maintenance. QA personnel use the HHR to update the pallet condition code and history to reflect the status of the individual munitions items and what QA actions were taken upon its return to the inventory. The RCU captures the updated information and transfers it to the PP. The PP then reconciles the RCU and HHR data and updates the inventory list. This function was not supported during the ACTD since the RF tag lacked sufficient fields and tracking capability to record inspection and maintenance performed on individual munitions.

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APPENDIX C. ANCHORING SEA ENTERPRISE: PLANNING FOR THE SUCCESSFUL IMPLEMENTATION OF RADIO FREQUENCY IDENTIFICATION (RFID)

Anchoring Sea Enterprise

Planning for the Successful Implementation of Radio Frequency Identification (RFID)

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Radio Frequency Identification (RFID) technology has demonstrated the potential to provide labor efficiencies that enable a smaller work force to do more. However, a solid business case must exist which would determine if RFID is truly the answer. Once the business case is completed, an implementation plan is required to ensure cost effectiveness and business process efficiencies are gained through the integration of technology. History has shown that we do not always follow proven business processes or good program management concepts when pursuing advancements in technology. Following established program management concepts are often time consuming, difficult to complete or not understood. It is much easier to adopt or modify past analysis and make it fit the bottom line of the project, without giving consideration to the long-term effects of these shortcuts. This results in a poor return on investment, increased direct labor costs, and inadequate system functionality that is incapable of delivering the intended product.

The Radio Frequency Identification (RFID) industry is exploding. As such, the Navy should be in the position to take full advantage of this highly competitive marketplace, and not consider proprietary systems. Why consider the current DoD system in which the maintenance, repair and upgrade budget exceeds the cost of the entire RFID infrastructure. Affordable Multi-protocol readers and interrogators are the way to the future. Real in transit visibility and total asset visibility are available, and the return on investment is efficiencies, readiness, information accuracy and timeliness. The government and industry are growing closer by the day with technology integration and should be able to 'SEE" all assets at the subcomponent level, assembly, delivery and any destination in the world. Why are we not moving in this direction? Is it because we are not following the vision of Sea Enterprise?

The Navy's current RFID policy encourages the adoption of the current DoD RFID system and uses the DoD RFID cost modeling for key cost factors and projections to support the integration of RFID into the Navy. This lemming effect has the potential to result in high-unbudgeted lifecycle costs for a system that will not support the Navy's supply chain transformation. The Army estimates that lifecycle maintenance costs to support the current RFID system to be five to six million dollars a year. If the Navy were

to adopt the current system, its baseline costs would quickly escalate out of control and not support business process efficiency transformation within our workforce. To accept status quo and procure tags at the cost of $125.00 a tag and not research the applicability of a tag that has more capability at a lesser costs is counterproductive to the greater good of the Navy and the goals of Sea Enterprise.

Sea Enterprise is not some lofty unachievable concept, it should not be placed on the same shelf as past initiatives that failed to attain service-wide transformation notoriety; Sea Enterprise is the primary mechanism for introducing business reform to improve business effectiveness, supporting the highest return of every program dollar spent. This simple, yet powerful strategy affords the Navy the opportunity to reinvest its fiscal resources. Today, and in the future, the use of technology will continue to offer vast opportunities to improve operational performance and minimize manpower within the Navy. As our shore based workforce and shipboard manning becomes smaller, leadership must look at innovative ways to gain higher productivity from a smaller workforce. As we move forward with efficiency transformation, we must cease looking at shoreline and sea-based boundaries of our work force, but consider ship and shore manning as an extension of labor, each complementing the other. Shipboard manning on the Littoral Combat Ship and the DDX class are the smallest in recent Naval history. To compensate for reduced manning, we must embrace the concepts of Distant Support, which emphasizes the need to transition portions of the ship's workload to shore, allowing the Sailors to focus on mission oriented tasks to fight the ship and maintain adequate levels of readiness. However, as the workforce ashore becomes smaller, the mission more focused and centralized; the challenge to move shipboard workload ashore will become increasingly difficult. We must pursue the creativity of Sea Enterprise to become more efficient to facilitate the vision of Distant Support.

The current Department of Defense In Transit System has been functioning for DoD since 1994. At its inception, the system was far superior and a significant step towards automatic data capture and asset visibility in the logistics chain. As with most information systems credibility and fidelity have been difficult to achieve. The current system has still not attained the needed credibility and fidelity to fully convince all users

within DoD it is the system of standard. It is important to understand since 1994 that DoD has still not gained a solid understanding of system development, integration and cost analysis.

Despite the fact that the DoD has funded the entire in transit visibility effort the nature of the current system is proprietary. The protocols and operating system can only function with the SAVI operating system software. Only SAVI readers can talk to SAVI tags and only the SAVI Business Process Server can process the information and supply data to the Global Transportation Network System. This indicates the system is proprietary, heavily dependent upon infrastructure, which is capable of only nodal visibility. The CONUS visibility nodes have been constructed for the past ten years and despite the fact that coverage at key DoD nodes has been installed, the system still remains extremely unreliable and the data portrayed in the in transit system suspect. Once the containers are transported out of the country and arrive at the designated point of debarkation visibility is lost. The O'CONUS visibility is often times more critical than movements within the United States. The information that is transmitted is only a tag serial number and nothing else. In order to identify the container and its contents, connectivity to an SAVI database server is required.

Despite the shortcomings and proprietary nature of the system the tag itself is extremely capable. It has data available from Transportation Movement and Control information to commodity information. The readers however are not as robust and suffer from technology hardware and software limitations. For instance, upgrades are not included in the contract and the entire array of readers currently in use by DoD requires upgrading to Microsoft Windows 2000 at an estimated cost of $7000 per site. This is not an upgrade to the reader capability, just a Microsoft Windows operating system upgrade. There is no maintenance contract for the infrastructure and as the system continues to age, components will degrade, and the costs to maintain the system will increase.

In response to the Office of the Secretary of Defense's RFID compliance mandate, the Navy is moving forward in evaluating the capabilities of current RFID technology to support supply chain transformation. These ongoing efforts, along with those of the CNO

N411 sponsored Ordnance AIT Skunk Works Team, will endeavor to provide a valid business case analysis for ordnance management using RFID. Integration of Automated Information Technology into the supply chain will achieve total asset visibility, and result in cost savings through reduced labor and overhead costs by leveraging the use of enabling technology, such as RFID. To ensure successful business transformation[1], it requires us to acknowledge the importance of industry lessons learned and key points from past implementation plans to ensure successful implementation and process change is achieved.

Throughout technology transformation, the Navy must capitalize upon the lessons learned by industry. This paper addresses the lessons learned from industry and emphasizes the importance of established program management concepts to ensure critical areas of technology integration are considered and mistakes are not repeated as the Navy moves forward to make effective business process improvements by leveraging RFID capabilities. While a great deal of the information portrayed in this document might be viewed as critical, this is not the purpose. It has been constructed from a critical viewpoint of Industry Leads, who have delivered systems and stand behind them. All of the issues raised in this paper can be and have been overcome. The solution costs and dependencies sometimes are not as palatable once the hurdles have been surmounted. This is no different than many other technical projects. The goal of the paper is to stimulate thought as to the reality of RFID technology as it exists today and for the near future, applies the ideas and concepts presented here to our own situation to provide clarity to our ideas and goals. Hopefully, this paper will provide Navy program managers with sufficient information to move ahead and implement realistic and cost effective RFID based solutions that are designed reasonably and provide a positive return on investment throughout the systems life cycle. RFID is a powerful technology, providing great functionality. It can offer unique solutions that no other technology can provide. If we are judicious in our use of it we will be rewarded with successful implementation and all that accompany such success. Blindly apply it, as a miracle like solution to all problems and failure will be an all to familiar term. As in all technical projects striving

[1] RFID Integration Acsis Inc Dave Harty Director of Research and Development

for the simplest approach and the least amount of effort that provides the greatest return will serve us well. [1]

The successful implementation of an RFID strategy depends on a clearly understood and well-supported plan. Five major steps are addressed in this paper and should each be carefully understood and applied for a successful implementation:

Create an RFID implementation policy for supply management. This basic step requires the agreement on the objectives of RFID implementation, the technology to be deployed, defining the data structure - i.e. what information needs to be stored for each item to provide the added value. [1] The user requirements must be completely captured in this document. The *"all to often"* forgotten step in requirements determination process is to overlook or minimize the needs of the operator or the user of the technology and to move forward on an easier path of acquisition or what the project lead believes to be the need. The stakeholders must be involved throughout the development of the plan. This document should be regularly reviewed to ensure that it is updated as implementation issues are resolved, but it should also be treated as the service policy for implementation to avoid different Commands/Departments addressing the issues in their own ways. Once this document is drafted, obtain Senior Navy Leadership's support and endorsement for the strategy and plan.

Document the Reasons for Adoption: This document should describe and quantify why the Navy is implementing RFID. First we start with some basics. Why do you want to tag it in the first place? Many projects should stop at this point. If we aren't solving a problem then do not proceed. There is no need to try tagging something simply to prove you can.[1]

Fundamental management practices and the goals of Sea Enterprise are the litmus test of this decision process, if the problem can be equated to having a cost to the Navy of ten million dollars a year and implementing RFID technology to solve the problem costs twenty million dollars a year, we should not move forward with the investment or implementation. A positive return on investment is the driving force to any successful

project. As with any solid cost analysis, accurate figures are critical to under tanding the value chain of the system and what the financial returns are to the Navy. A g eat number of projects have concentrated on some magical tag cost (usually based on no hing) only to find out the infrastructure required to support those tags has a price equal o the defense budget of a small nation. There are plenty of systems with high cost ags with great ROIs, and even more systems with low cost tags that have a horribly n gative ROI when the total system cost is calculated. Simply put if the total cost of the sy tem is more than the value of the benefits then STOP!

Return on investment analysis or cost modeling must never be an estimate o a task that is outsourced to an existing RFID service provider. The recent PM Joint AIT o fice's contract solicitation for DoD RFID services indicates the cost modeling was done by SAVI technology, the current RFID service provider. The Navy's recently published RFID plan uses the same cost modeling data to support the proposed implem ntation plan. This indicates that the basic RFID project development steps addressed earlier were not followed and sets the stage to potentially buy into a system, which provi es neither a favorable ROI or desired labor efficiencies within the inventory managemen business processes to align with the concepts of Sea Enterprise.

Once the sanity check is completed and a positive ROI has been validated, o r documents should include several points, a strategic mandate from Leadership, a desire o increase efficiency of internal processes, a move to integrate information between ma ufacturers, wholesale and retail activities, and the financial cost benefit of adoption sho ld be estimated and documented. Remember that the benefits should include both irect benefits in labor savings as well as indirect savings and benefits to total asse visibility in being able to accurately track shipments throughout the movement and deliv ry processes, down to the management of material within the warehouse. The b nefits and features provided from RFID technology are impressive; however, one must remember that they are potential features and benefits, not guaranteed ones. It is the un erstanding of what can truly be delivered and utilized in the individual implementation lan that determines the project's success or failure.

Develop an implementation model. This document will define the implementation strategy, covering such items as the proposed technology provider (and second supplier in case the first can not deliver the required capability on time), safety issues associated with implementation, discussions and agreements with unions, staff communication plan, testing processes etc.[1]

The single greatest item that will have to be dealt with in implementing RFID is the environment. The scope of the project must be narrowed, however, it cannot be simplified as the other components simply for the fact that it is the least understood, yet the results of the project can have the greatest impact on the system, usually negatively. For the purposes of planning, let's define the environment as the physical (including unseen items such as radio and magnetic waves) items between and surrounding both the tags themselves and the area in which we are trying to read the tags. This would include the items that the tags would be placed upon as well. We will need to address these categories and how they affect decisions such as systems architecture, actual RFID components to be used (types of tags, frequency, and readers), application logic, physical environment and business processes. This leads us to categorizing some major areas, which we need to address in order to achieve success in our implementation. We can break our system requirements into several major areas of concern. While there is no steadfast rule in how to categorize these or the completeness of this list, industry experience has shown each of these to be significant factors to consider. Researching these areas will require technical support to gather the information needed to clearly understand these areas to ensure system limitations or overall functionality is documented before equipment procurement or installation takes place. The areas are: Item Environmentals, System Environmentals, Data Requirements, Tag Structure, Tag Mounting, Reader Capabilities, Antenna Selection and Placement and Software.

The planning steps, which we have addressed, were used to produce successful results in an OPNAV N41 sponsored test. TURBO CADS 2005, a Joint Staff sponsored exercise,

[1] RFID Integration Acsis Inc Dave Harty Director of Research and Development

was used to evaluate RFID capabilities and determine the Service's needs to leverage RFID technology and gain business process efficiencies and *Total Asset Visibility of In Transit Material*. Turbo Cads 2005 was an opportunity to demonstrate and evaluate state of the art active RFID technologies and determine their applicability to ordnance management and logistics. The RFID demonstration was designed to evaluate the current In Transit Visibility and Total Asset Visibility system and two Satellite providers with two different Active RFID asset devices. The main objective was to investigate mature RFID technology off the shelf and incorporate it into the logistics process of containerized ammunition shipments. A further objective was to attempt to communicate with the asset devices inside a closed shipping container.

The demonstration involved seven containerized ammunition shipping containers loaded at Crane Army Ammunition Activity and shipped to Ordnance Annex Guam. The demonstration provided a side-by-side comparison of the current Department of Defense system and associated infrastructure to two similar in design but extremely different in capability and application active RFID devices. In addition to the asset devices, two satellite communications providers; Iridium and Orbcomm were also compared. The active tags were placed on pallets in shipping containers that were modified with antennas and modems in order to communicate with the satellite systems.

For the purposes of this demonstration the definition of Real Time Asset Visibility was defined as asset data and global positioning information provided every two hours. Five containers were instrumented with a combination of active master tag and active pallet tags. This allowed for the pallet tag to monitor environmental conditions and carry asset data. The master tag strategy utilized in five containers maintained the serial numbers of the pallet tags inside the container and was hard-wired to the satellite modem. The master tag was not capable of communicating with the pallet level tags. Data from the pallet level tags could only be recovered via a Handheld or fixed reader after downloading the container contents. The remaining containers were equipped with networking tags that provided a capability to communicate to or through each other and an active transceiver, which communicated with the pallet tags and the satellite modem.

This strategy set the stage for the evaluation of the capability to communicate directly to a pallet inside a sealed shipping container.

The demonstration proved that technology could free the Department of Defense from a heavy dependency upon current integrators and reader infrastructure and near zero percent visibility of assets moving through the supply chain. The results of the test are extremely convincing. Asset data and global positioning updates were automatically provided every two hours identifying the contents and location of the containers. Of the two technologies, which incorporated satellite communications only the devices with networking capability achieved pallet level communication. In fact, while the containers were in route, data such as condition code was changed in response to a scripted demonstration of implementing a Naval Ammunition Reclassification (NAR) action and changing the DD-Form 1348-1 Supply Document data. Once the information on the tag was updated, the information was then transmitted back via satellite confirming the pallet /asset tag was updated.

As a result of incomplete planning, DoD has ended up with islands of SAVI automation throughout the enterprise and no bridges. As with most emerging technologies, organizations will rush to integrate hoping to increase efficiencies, avoid cost and grow their bottom line. When a 'new technology' avails itself, rarely do we thoroughly plan nor study the implementation or integrate correctly. More often than not 'WE' suffer from the 'GET A GADGET' phenomenon. This clearly supports the need to closely follow the planning steps of business process analysis followed by a re-engineering effort to improve or make the process as efficient as possible without automation. Only after the process has been re-engineered and efficiencies been made, should a pursuit of automation occur. Integration is a requisite step occurring subsequent to process and return on investment analysis and is not a prerequisite. If an inefficient process is automated inefficiencies are performed faster providing a false positive result.

The TURBOCADS-2005 test results clearly indicate that the Navy can move forward in implementing a streamline RFID capability without having to invest in a cost prohibitive hard-wired infrastructure currently in use by DoD. The wireless RFID capability has the

potential to establish the foundation to revolutionize supply chain management and serve as an enabler to achieve the need to integrate our sea and shore workforces to execute distance support concepts. A review of processes, policies and procedures are a required step prior to any AIT integration. Without a focused user requirements definition identified and the policy changes made to support AIT integration, the return on investment will be minimized and RFID implementation efforts will fall short of expectations. New technology is available and capable of enhancing supply chain management throughout the Department of the Navy. Unless the Navy realizes the importance of starting with a clean project management slate, which focuses on the industry proven project planning steps, clearly understands RFID applications as they relate to the supply chain, and focuses upon the goals of Sea Enterprise, we will never realize the full capabilities of RFID technology or an integrated workforce capable of fulfilling the vision of Distant Support. Technology can be a force multiplier capable of empowering our workforce, reducing costs and increasing efficiencies; as long as RFID project management concepts are embraced, process reengineering is understood and the goals of Sea Enterprise at kept at the forefront. If we follow these proven management steps, we will have positioned our Service for the successful implementation of RFID technology and achieved the goals of Sea Enterprise.

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